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Water and Electric Current for Poplar Bluff

MISSOURI CITY INSTALLS ELECTRIC GENERATORS DRIVEN BY UNAFLOW ENGINES IN MUNICIPAL PLANT

WITH ITS HEAD WATERS in the Iron Mountains of Missouri, the Black River increases rapidly in size, attaining at Poplar Bluff, a stream of considerable proportions. The water is clear and sparkling, free from the contamination of city sewage and as healthful for domestic use as can be had from a surface source. Citizens of Poplar Bluff years ago recognized this natural source for their water supply, and have operated a municipal pumping plant these many years. This plant was steam driven and a paying investment for the municipality.

A few years ago, the growing city made demands upon the plant equipment which could not be met, so additional pumping machinery was installed. Then it became evident that greater economy could be maintained if the city were equipped to supply its own current for street lighting with what additional load could be secured from residences and commercial houses, even considering the existence of a competing central station.

After a lively political campaign, necessary and usual with cities of this size where the expenditure of considerable money is involved in a new enterprise, the required bonds were voted, specifications drawn and bids received two years ago. An entire new building has been erected covering three times the space of the original plant. The new building is entirely of brick and steel with red tile roof, flashings and gutter are of copper and window sashes of steel. A three-ton hand operated crane is installed in the engine and pump room.

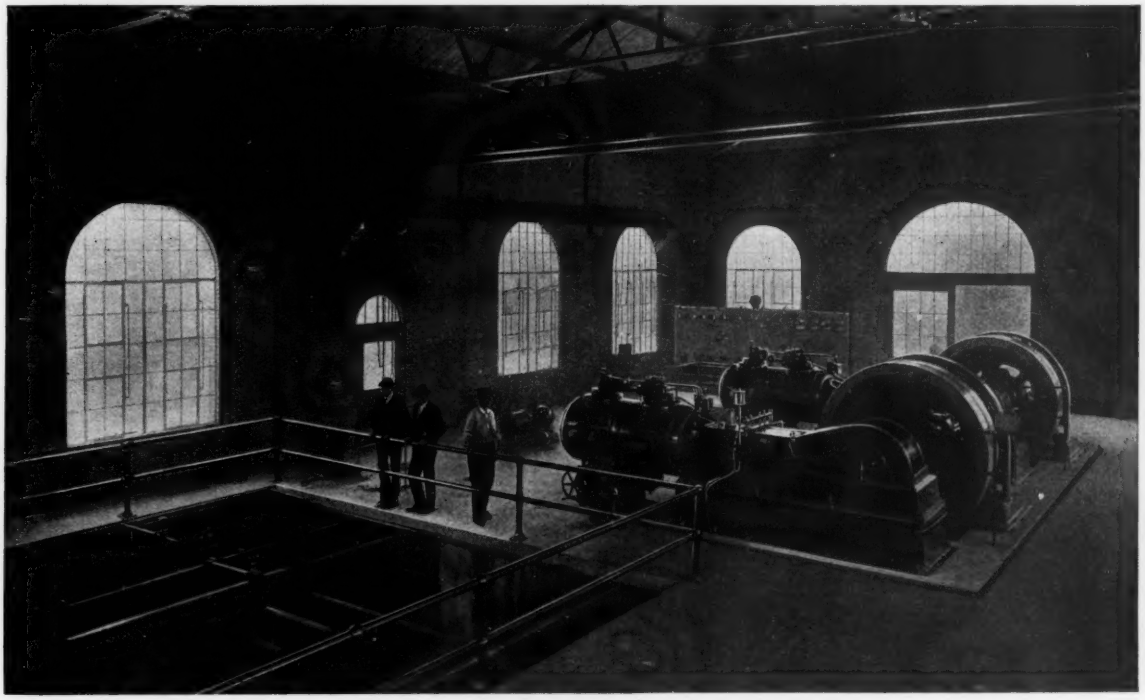


FIG. 2. GENERAL VIEW OF THE ENGINE ROOM

Two generating units with auxiliary equipment have been installed, and since last spring uninterrupted service has been furnished.

Steam Generation

In the boiler room are two O'Brien water tube boilers of 150 hp. capacity each, with space allowed for another boiler of 300 hp. capacity. Original plans called for the installation of this new boiler, but such attractive guarantees were secured from the engine builders that the boiler installation was deferred and by careful management it has been demonstrated that until the load has been increased considerably, the present boiler equipment will furnish ample steam.

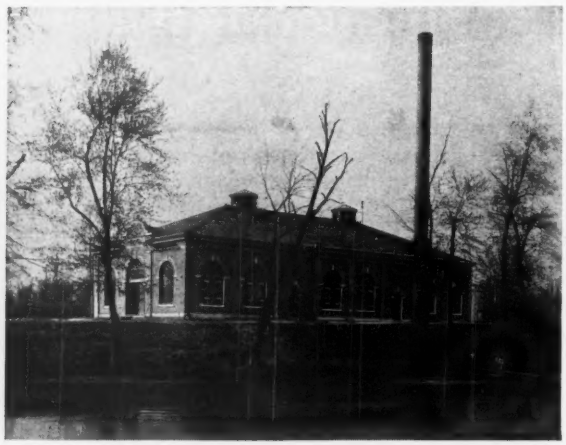


FIG. 1. POPLAR BLUFF PLANT AS SEEN FROM ACROSS THE RIVER

These boilers are operated at 150 lb. pressure and are equipped with Hawley down-draft furnaces. At present Illinois mine-run coal is used, which comes to the plant in cars switched onto a private track by the side of the plant. Space for coal storage is in front of the boilers; the handling of coal and stoking is all done by manual labor.

Feed water is taken from the hot well of the condensers supplemented by makeup water from the warm condensing water; this all goes through a 2500 lb. per hour Cochrane V-notch recording meter. The boiler feed pumps, of which there are two, take the water from the meter and pass it through a 600-hp. closed heater to the boilers.

Pumping Engines

All pumping equipment is located in a pit in the engine room which gives to the pumps a suction head of 10 ft. 6 in. The suction pipe from the river is 12 in. and supplies water to three pumps; two of these are Worthington tandem compound, duplex plunger type pumps, 10 and 16 by 8½ by 10 in., each having a rating of 350,000 gal. per 24 hr. The other is a cross-compound condensing plunger type, Laidlaw-Dunn-Gordon pump with flywheel; its dimensions are 12 and 24 by 10 by 18 in. with a capacity of 2,000,000 gal. in 24 hr. The vacuum maintained in this condenser is 28 in., the condenser being built into the suction line so that the water is drawn over the coils and is then pumped into the mains. On account of the quantity there is no perceptible rise in temperature of the water. The head pressure carried on the pumps is 70 lb., a standpipe being used to take care of minor fluctuation in demand.

Electrical Equipment

The principal new equipment of the plant is the generating units, their condensers, the switchboard and their auxiliaries. These units each consist of a 225-kw., at 90 per cent power factor, General Electric Co., a.c.

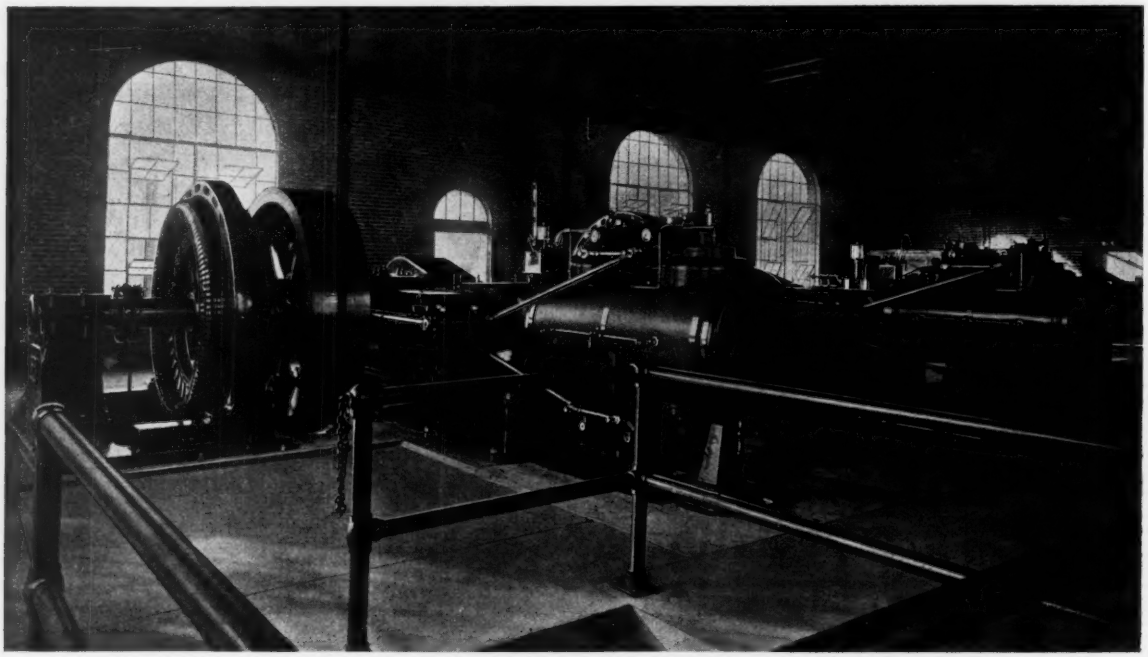


FIG. 3. VALVE GEAR SIDE OF GENERATING UNITS

generator delivering three-phase current at 2300 v., 60 cycles, direct-connected to a Skinner Universal Unaflow engine with cylinder dimension 21 by 22 in. and run at 200 r.p.m. The engines are of the standard type which operate either condensing or noncondensing with small clearance, and there is no change in the engine to accommodate itself for the changed exhaust pressure condition except the automatic change taking place by which the auxiliary exhaust valves are thrown in or out of operation. Details of this valve gear are described in another article in this issue.

Two eccentrics are employed for operating the valves of this type engine. A plain fixed eccentric operates the auxiliary exhaust valves when the engine is running noncondensing as explained in the article referred to, while the steam valves are operated from the eccentric pin of the flywheel governor. This gear is capable of operating at comparatively high speeds at the same time eliminating the side pull of the cam against the valve stem when the valve is being raised. The admission gear consists of one rocker arm, with casehardened removable steel cams which dip into an oil bath and control the operation of the valves by means of forked levers or lifters, on which are mounted casehardened rollers bearing against the cams. The formation of the cam is such that the roller is always in contact with it, which results in a quiet lifting and seating of the valve even at high speeds. The adjustment of the valve, cam and lifter is made by one set screw located above the lifter and can be made while the engine is in operation. The spring is mounted in the housing but not in the steam space. Labyrinth or water-groove packing is used, which will maintain its steam tightness without attention indefinitely.

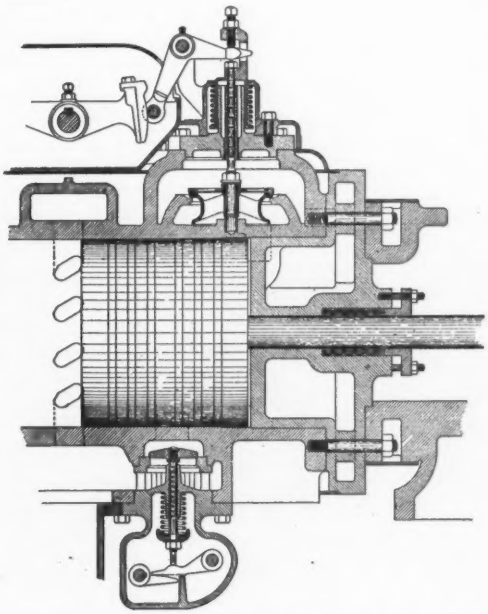


FIG. 4. CROSS SECTION ADMISSION VALVE GEAR

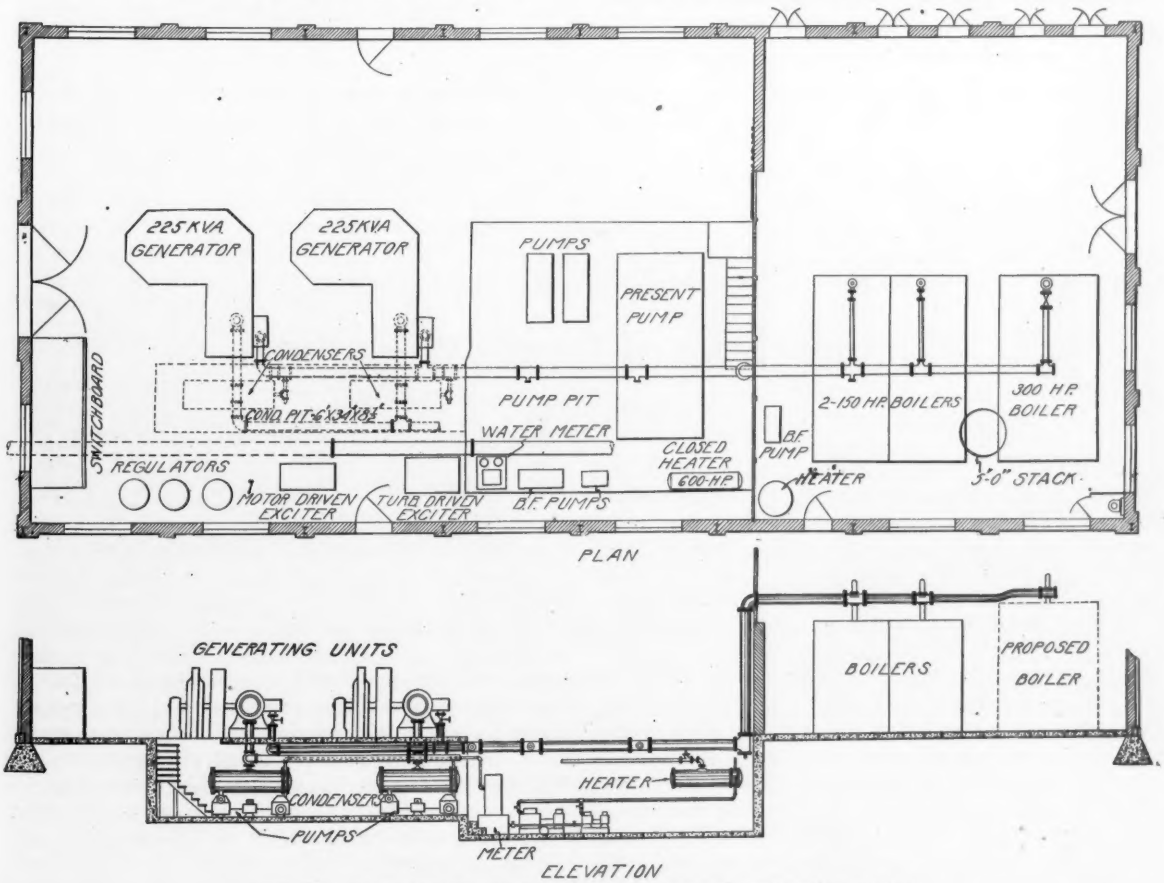


FIG. 5. PLAN AND ELEVATION OF POPLAR BLUFF MUNICIPAL PLANT

Another special feature of the engine is the self-expanding poppet valves employed. The upper part of this valve is not rigidly connected to the lower part, but allows an expanding and telescopic action and comes in contact with its seat shortly before the lower part with the result that both seats make steam-tight contact irrespective of the difference in expansion of the cylinder and the valve metal. The telescopic action is never more than 0.003 or 0.004 in., and steam tightness between the two elements of the valve itself is obtained by the peculiar construction of the steam spring metal packing rings. The spring between the valve stem nut and the upper part of the valve is not essential to the operation of the valve, its function being to serve as an elastic stop.

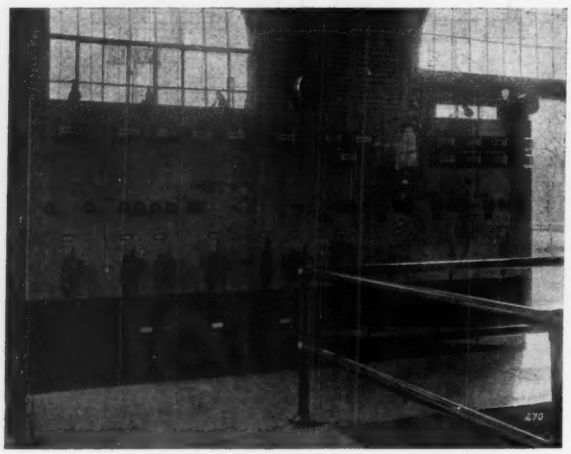


FIG. 6. CONVENIENTLY ARRANGED AND ADEQUATELY EQUIPPED SWITCHBOARD IN POPLAR BLUFF PLANT

Each engine is provided with a gravity system of automatic lubrication consisting of a filter, oil and water separator, piping, pump and sight feeds. The reciprocating parts of the engines are surrounded by oil shields which prevent any oil reaching the exterior of the engine. Four feed pipes carry the cylinder oil from a Hills-McCanna pump to the cylinder, the points of application being one at each steam valve and two near the center of the cylinder.

Both generating units are placed on one foundation which contains 110 tons of concrete. By this arrangement, either unit when being operated separately is given double foundation support with the result that no vibration is apparent.

Serving each engine is an Alberger surface condenser of the horizontal type located in the tunnel just beneath the engines. Each condenser has a surface of 600 sq. ft., and beneath the shell is a 6 by 10 by 10 by 12 in. single cylinder steam driven, combined air and circulating pump. Each is designed to condense 5000 lb. of steam an hour and maintain a vacuum of 26 in., that is 4 in. absolute pressure, with circulating water at 80 deg. F. (27 deg. C.)

Separate excitation is supplied either by a motor driven G. E. unit consisting of a 25-hp. induction motor and a 15-kw. d. c. generator run at 1800 r.p.m. on 3-phase currents at 2200 volts, furnishing exciting current at 125 volts, or by a 15-kw. Kerr-American turbine driven unit run at 3600 r.p.m.

For the control of current distribution, an eight panel switchboard is installed; this is made up of two generator panels, two exciter panels and four distributing panels. Besides the regular equipment of switches, circuit breakers and measuring instruments, the switchboard has mounted upon it a three-point electrolytic ground detector, a synchroscope and a Tirrill voltage regulator.

For the street lighting currents, constant current of 6.6 amp. is furnished, three, 15-kw., constant current transformers being installed for regulating the current from the 2300-volt primary circuit.

Credit is due the Fuller-Coult Co., of St. Louis, for the engineering work connected with the selection and installation of the machinery and the reconstruction of the plant.

Valve Gear of Uniflow Engines

Methods Employed to Operate Valves for Condensing and Noncondensing Types

PREVIOUS articles have discussed the economy and advantages of the uniflow engine under certain conditions as compared to the counterflow type. It is here proposed to direct attention to the details of the cylinder construction and valve operation of various uniflow engines.

Because of the fact that the steam consumption curve for various loads is comparatively flat, this type of engine is particularly suited for fluctuating electric and power loads and for rolling mills. One of the largest yet constructed, is a 44 by 50-in. uniflow engine which was installed for rolling mill service at the Youngstown Sheet & Tube Co. It was designed to operate condensing with a vacuum from 20 to 24 in., a normal steam pressure of 170 lb. gage, 75 deg. superheat, run at from 65 to 110 r.p.m., and have a maximum brake horsepower of 2100.

Poppet Type Inlet Valves

APPARENTLY the principal difference in the present commercial types of uniflow engines is in the arrangement of valves, valve gear and methods of adapting the engines to condensing and noncondensing conditions. Inlet valves may be of any type, such as poppet, Corliss, piston, or slide, but are usually of the poppet type, due to the quick opening and closing features and adaptability to high temperatures. Tightness of the inlet valves, under all conditions of load and temperature, is quite necessary, as compression in uniflow engine extends over about 90 per cent of the stroke, and any leakage will require more power for compression. To insure tightness, the poppet valves are usually of the balanced type and made either with the seats expanding at the same rate as the valve body or constructed in such a manner that the parts of the valves are separate

and self-adjusting. Operation of poppet valves is secured either by cams connected through bell cranks or straight rods to the eccentric on the main shaft or directly by cams mounted on auxiliary shafts parallel to the travel of the piston.

Uniflow Exhaust

Exhaust steam is commonly discharged through a ring of ports encircling the middle of the cylinder, the ports being uncovered by the movement of the cylinder piston during its travel. The provision of a number of ports gives an area for exhaust which is several

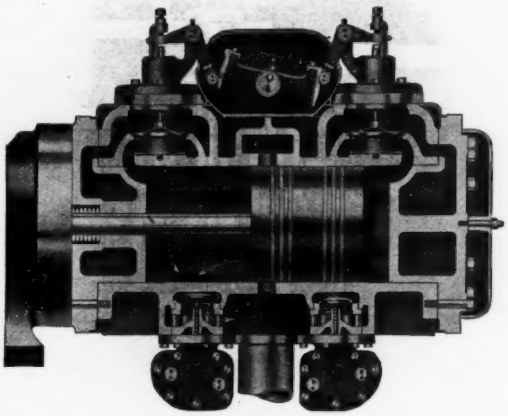


FIG. 1. SECTION OF SKINNER UNAFLOW CYLINDER

times that obtained with other forms of valves, giving a rapid lowering of the cylinder pressure to exhaust pressure. This is quite necessary because the duration of the exhaust is less than in the counterflow engine.

To reduce the amount of steam being compressed when operating noncondensing, auxiliary exhaust valves are sometimes provided, which, if operated by the valve gear, are of the poppet type but are not balanced as they are opened only when the pressures on the 2 sides are equal. Auxiliary exhaust valves which operate independently of the valve gear increase the clearance vol-

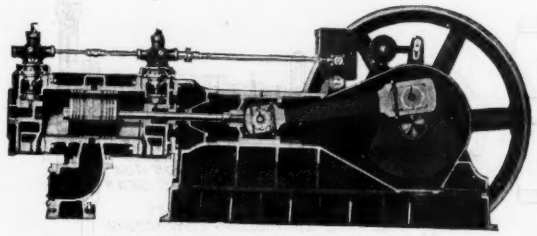


FIG. 3. SECTION OF AMES UNIFLOW CYLINDER

ume or eject steam should the compression become excessive.

Low initial pressure or high back pressure requires greater clearance in uniflow engines, and in order to obtain compression equal to the initial steam pressure, a smaller volume of steam is required for noncondensing operation than for condensing, owing to the difference in the densities of the steam. Consequently, a noncondensing engine must have more clearance or the amount of compression must be reduced. Uniflow engines having a fixed low clearance are equipped with auxiliary valves to delay the point at which compression begins. In another type, clearance pockets are provided in which the additional steam can be compressed and thus prevent excessive pressure. To give more clearance, engines built for noncondensing service are often fitted with pistons having cupped or concave heads.

Skinner Unaflow Engine

Admission valves of this engine are opened by the action of the enclosed rocker arm located over the middle of the cylinder, as shown in Fig. 1. The ends of this rocker arm are fitted with removable case-hardened steel cams, which dip into an oil bath and control the operation of the valves by means of forked levers or lifters, on which are mounted case-hardened rollers bearing against the cams. The design of the cam is such that the roller is always in contact with it.

Adjustment of the valve, cam and lifter is made by raising or lowering the set screw located directly above the lifter.

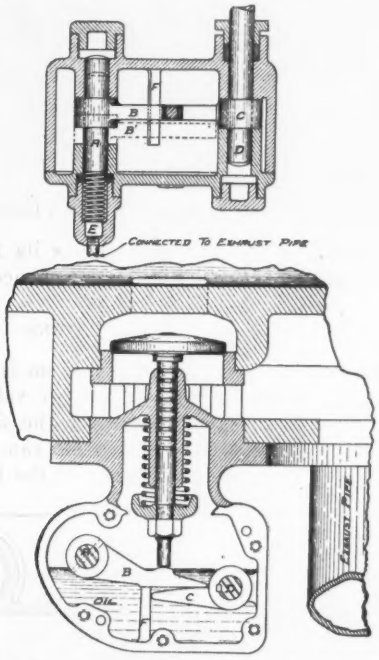


FIG. 2. GEAR FOR SKINNER AUXILIARY EXHAUST VALVE

Shown in Fig. 2 is a section view of the auxiliary exhaust valve gear. A is the shaft supporting idler B, which is operated by shear cam C. Cam C is operated by the engine valve gear which is connected to shaft D on the outside of the cam box. When cam C raises idler B, the latter raises the single-seat exhaust valve, the stem of which projects within a short distance of idler B. The spring around the valve stem has only sufficient tension to secure quick closing when operating at high speeds. Pocket E is connected to the central exhaust port by means of a small pipe; and the function of the spring in this pocket is to keep the idler, through its attached shaft, in register with the stem of the valve and the cam, C, directly underneath. When the vacuum reaches a predetermined point, it overcomes the tension of the spring in pocket E, and draws the shaft into the pocket. This, in turn, shifts the idler to position B' and out of register with cam C, so even though the cam

operates as before it cannot lift the valve. Thus, the exhaust valve remains closed at all times when vacuum exists in the exhaust pipe, and is kept tightly closed by the cylinder pressure acting on top of the valve.

Bridge F acts as a slide and rest for the idler, and holds it at the proper height, so that if the vacuum fails, the spring, by asserting its force in pocket E, will slide the idler between the cam and valve stem, where-

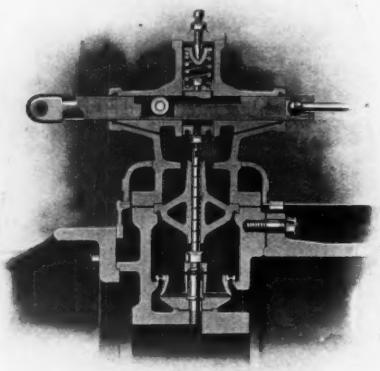


FIG. 4. BONNET AND VALVE OF AMES ENGINE

upon the auxiliary exhaust valve begins its functions, and the engine automatically becomes a noncondensing engine.

AMES-STUMPF UNIFLOW ENGINE

IN THE OPERATION of this engine, steam is admitted to the cylinder by a double beat poppet valve shown in Fig. 4, which is lifted by a roller in the sliding bar when it comes in contact with the lifting cam. Closure of the valve is effected by the spring in the top of the bonnet, the lower end of the spring resting on top of a circular crosshead to which the lifting cam is rigidly bolted.

Engines furnished for condensing operation are equipped with automatic bypass valves, as shown in Fig. 5, to prevent undue compression in the cylinder resulting from a loss of vacuum. These valves are operated automatically, when the vacuum is partially or totally lost, by existing conditions in the exhaust chamber of the engine, these conditions being communicated to the valve piston through a small pipe connection. By means of a lock-nut adjustment the tension of the spring may be varied so that the valve will operate at any desired degree of vacuum.

YORK UNIFLOW ENGINE

SUPPORTED by long spindles and guides, the steam valves of this engine are placed in a horizontal position and operated by oscillating levers provided with rollers and curved cam pieces attached to the valve spindles. Oscillating levers for both valves are mounted on a single shaft which receives its motion from an eccentric mounted on the lay shaft. This lay shaft runs alongside the engine and is driven from the main shaft, through a drag crank and shaft, by means of spiral gears.

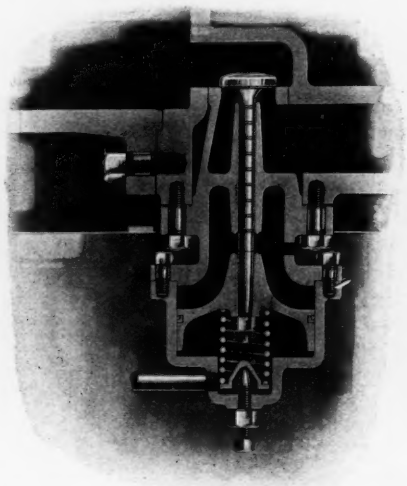


FIG. 5. SECTION THROUGH AUTOMATIC BYPASS VALVE

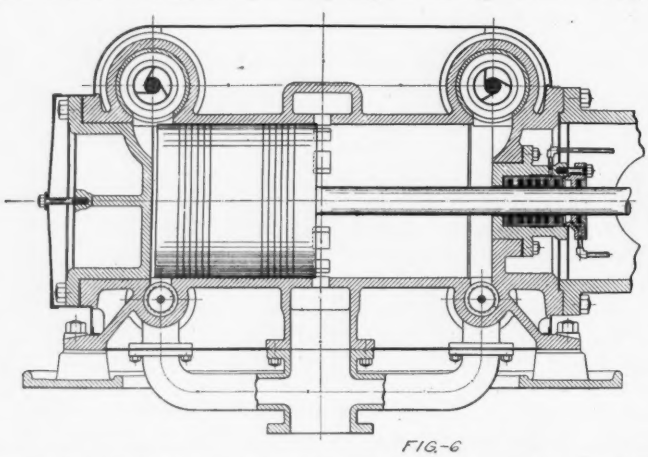


FIG. 6. YORK UNIFLOW ENGINE CYLINDER

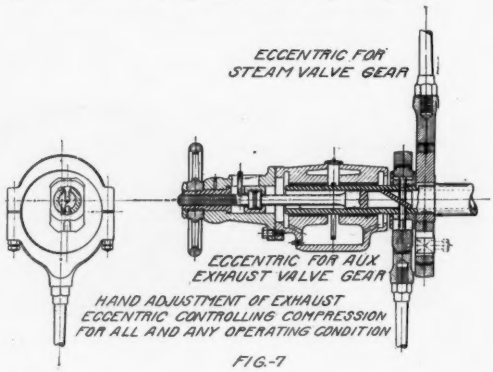

ECCENTRIC FOR STEAM VALVE GEAR
ECCENTRIC FOR AUX EXHAUST VALVE GEAR
HAND ADJUSTMENT OF EXHAUST ECCENTRIC CONTROLLING COMPRESSION FOR ALL AND ANY OPERATING CONDITION

FIG. 7. VARIABLE ECCENTRIC FOR CONTROLLING COMPRESSION

Different load conditions are met by the use of a compound eccentric operating the steam valves. A small eccentric is keyed to the shaft and a larger one which may slide on the shaft is connected to and controlled by the shaft governor. By the shifting of the large eccentric, the combined eccentricities become such that a virtually constant lead is maintained, while the throw increases according to the load requirements.

Being completely balanced, the shaft governor consists of 2 pendulums which by means of short arms shift a sleeve mounted on the shaft. This sleeve is connected to and shifts the large eccentric. A hand speed adjustment is provided which allows a change in the speed while the engine is in operation, an increase of 50 per cent being possible.

To regulate the degree of compression according to the operating conditions, auxiliary exhaust valves of small diameter are provided which are operated similar to the steam-admission valves, except that in this case the eccentric is arranged on a slide block which is keyed to the shaft. By setting the slide block in such a position relative to the eccentric and steam-valve gear that the auxiliary exhaust valves begin to open at the same predetermined point, say approximately at dead center, the eccentric can then be moved either automatically or by hand into any position on the block to secure closing of the valve at any point of the stroke. Instead of having the eccentric controlled by a governor, a shifting

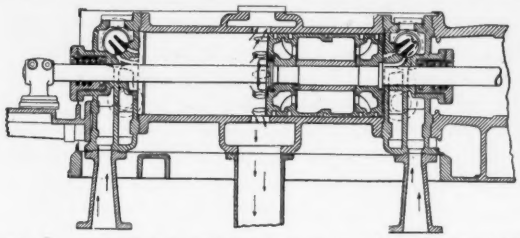


FIG. 8. SECTIONAL VIEW OF C. & G. COOPER UNIFLOW CYLINDER

device operated by hand while the engine is in operation is provided, as shown in Fig. 7, making it possible to move the eccentric to any position and thus obtain any desired degree of compression.

The valve spindles are lubricated by means of forced lubrication which passes oil along the spindle through spiral grooves, onto the guide and then into the steam space. Ground into long bushings, the spindles are also provided with labyrinth packing consisting of small circular grooves.

C. & G. COOPER UNIFLOW ENGINE

THIS ENGINE is equipped with an improved Corliss gravity releasing valve gear for the steam admission valves, the exhaust steam being discharged through the central ring of ports when uncovered at the end of the piston stroke.

Figure 9 shows a 19 by 30-in. uniflow engine of this type on the erecting floor. Mounted on the cylinder is a bell crank actuated by an eccentric through the ordinary eccentric and connecting rods and rocker arm. The latching or hooking-up operation of the valves is performed by a pick-up plunger, through the action of gravity, no springs being employed.

Cutoff is controlled by the action of a governor through rods to the knockoff cams.

NORDBERG UNIFLOW ENGINE

FIGURE 10 shows the longitudinal and cross sections of the Nordberg uniflow engine fitted with poppet valves.

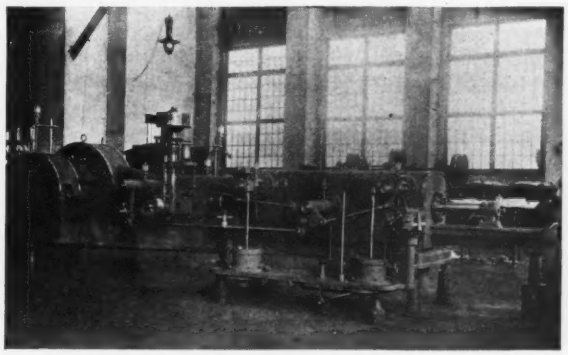


FIG. 9. C. & G. COOPER UNIFLOW ENGINE ON ERECTING FLOOR

Positive opening and closing of the valves is secured by means of cams operated by eccentrics which are mounted on a lay shaft geared directly to the main shaft. The steam valves are of the double beat type and seat in removable cages which are ground steam tight into the cylinder head castings.

Located between the eccentrics on the lay shaft is a governor of the inertia and centrifugal type, which controls the cutoff of the steam valves by varying the effective throw of the eccentrics.

Adjustable cataract relief valves, located at the bottom of the cylinder, automatically relieve the compression in case the vacuum is lost. The steam is compressed into the jacket space and main steam piping connected to the boiler.

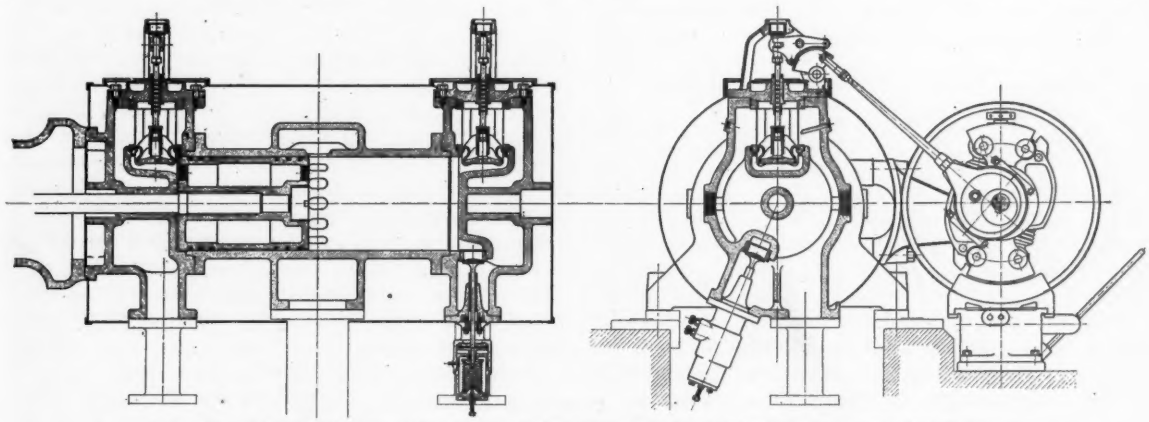


FIG. 10. LONGITUDINAL AND CROSS SECTIONAL VIEWS OF NORDBERG UNIFLOW ENGINE

Power Plant Instruments as an Investment---I

How Far Does it Pay to Go in the Purchase of Instruments to Show Operating Conditions in the Power Plant? By M. A. Saller

TREMENDOUS strides have been made during the past 10 years in connection with the development of indicating, recording and metering instruments for power plant work, until at the present time the great number and variety of instruments advocated as desirable for increasing plant efficiency, or preventing losses of different kinds, makes it quite a problem for the engineer to decide just how far he should go in the investment of funds in this equipment.

Some idea of the number of different kinds of indicators, recorders, gages, meters, etc., available at the present time in fully developed and workable form can be had from the following partial list:

Thermometers for recording and indicating temperature.
Gages for indicating and recording pressures and vacuums.
Flow meters for measuring steam and air.
Meters for measuring water.
Weighers for automatically weighing coal and ashes.
Indicators for visualizing the work in the engine cylinder.
Draft gages for indicating draft and differential pressures.
Boiler efficiency meters for giving a check on the overall efficiency of the boiler unit.
Speed indicators and tachometers for showing the speed of shaftings, engines, machinery, motors, etc.
Counters for registering number of movements, etc.
Calibrating machines for checking and testing thermometers.
Gage testers for testing and checking gages.
Calorimeters for ascertaining the quality of steam.
Calorimeters for testing heat value of coal.
Planimeters for measuring areas, record charts, etc.
Electrical meters for measuring voltage, current and power.
Pyrometers for high temperature observations.
Flue gas analysis apparatus.
Log-book for collating data obtained, etc.

While it will be admitted that some of the instruments mentioned above could be installed to advantage in almost every power plant, it is, of course, obvious that the expenditure for the instruments, and the care and attention required in looking after them, would not be warranted in every case, and since all of these appurtenances cannot be purchased and used, it becomes a nice question for the engineer to decide which of them can be used to best advantage; i.e., which could be made to pay the largest return on the investment, taking in account safety, economy, increased production and improved working conditions.

In considering the purchase of any power plant recording, indicating or metering appliance, it should be borne in mind that the instrument is merely a means to an end, and that the instrument and the records it produces will not in themselves improve or better operating conditions; but these records should serve as evidence by which the engineer is guided in investigating and attempting to remedy conditions that are at fault.

For instance, if a feed-water meter shows that the evaporation of the boilers is only 5 or 6 lb. of water per pound of coal, the instrument only becomes a good investment and the information rendered valuable when the engineer and fireman, prodded by the poor showing made, endeavor to locate the causes and reasons why the evaporation is not up to 9, 10 or 11 lb. of water per pound of coal, as it should be. In other words, the purchase of an instrument merely to produce charts and records, and figures to be set down in a log book never to be used intelligently in checking the efficiency and improving the economy of the plant, is not a good investment.

Hence, the purchase of any metering or recording device is not warranted and justified unless the co-operation of the plant operators is secured in making daily use of the records and information obtained. As stated above, the instrument is merely a means to an end, a link in the chain which helps bring up efficiency and output. Without the co-operation of the engineer and the use of proper equipment, the installation of all sorts of indicating, recording or metering devices would be of no avail in bettering efficiency or increasing capacity.

The "personal element"—the ability and faithfulness of the men who operate the plant—is, after all is said and done, the most vital and important factor in connection with the economical and efficient operation of a plant. If the operating force does its work carefully, conscientiously and completely the need and necessity for many types of instruments is overcome; but in the great majority of plants the incompleteness of the staff, their incompetency or carelessness, makes it necessary to install equipment which will serve to act as a tell-tale or check upon the work which they have done or have to do. It is for this reason that in the large plants where a greater number of men have to be depended upon, and where the sense of responsibility covering the entire operation of the plant is not as deeply engrossed as where one or two men are in complete charge, the necessity for a more complete range and equipment of instruments is more necessary than in the smaller plant.

The nature of the equipment installed in the larger power stations—equipment that often has its efficiency seriously impaired by any change in operating conditions—makes it also more necessary to have a complete set of checking instruments to insure the most favorable operating conditions at all times.

In the large plant the installation of recording, metering and indicating instruments will also usually show a better return on the investment than the small plant. This for the reason that while the cost of the instrument for the large plant is usually not a great deal more than the cost of the instrument for the small plant, the possibilities for realizing savings are better; i.e., an instrument installed in a small plant may effect a saving of say 3 per cent on the coal bill; in a large plant the saving may also be 3 per cent; but the actual saving in the large plant will be many times greater because of

the fact that the coal bill in the large plant is a great many times larger than in the small plant.

In selecting power plant instruments, preference should always be given to those that produce daily or weekly chart records of performance, because these charts can be filed away for future reference and record, and can be used at the end of the week or month for glancing back over the performance of the plant with a view to detecting any possible opportunities for improvement, any falling off in efficiency, etc. The plain index or indicating equipment is satisfactory and very accurate as far as it goes; but in order to secure a complete record, it is necessary to make frequent readings, and for these readings the operating staff must be relied upon. There is also the opportunity for errors in taking the reading and noting them on some form of data sheet, etc. With the index or indicating equipment also no record is secured as to the performance of the plant between the times that the readings are taken. Therefore, on all important instruments or meters it is highly advisable to have the recording features. Most commercial instruments of today are provided with a combination of three features: a recording feature for producing a chart record; an indicator for giving the momentary load or reading, and an integrating device for enabling a total reading being taken for a period of an hour, or a day, or a week, etc., independent of the chart record.

Very frequently it will be found on investigating the subject that the usefulness and success of one type of instrument will depend upon the employment of still another type of instrument; in other words, it is frequently necessary to use a complete set or combination of instruments for securing the ultimate result.

Take, for instance, the record of the feed-water meter. A feed-water meter will give a graphic record of the rate at which the water is fed to the boilers, which will indicate the nature of the load on the boilers, when it is heavy and when it is light, whether the boilers are being fed regularly or spasmodically, etc.; but if it is desired to use the record of the feed-water meter in checking fuel consumption, it is also necessary to have a record of the quantity or weight of coal fired under the boilers. Then if it is desired to check against the quality of the coal, the matter of whether it is being completely consumed, the investigation should be carried further by means of the draft gage, Orsat apparatus, coal calorimeter, etc. From the preceding, it will be seen that the farther it is desired to trace the exact behavior of the plant the farther on must be carried the chain of instruments and meters, all dependent to an extent on those before it.

As a general rule, the average power plant instrument or meter is a fairly delicate and sensitive piece of apparatus, and for that reason it requires that good care be taken of it. The instrument should not be installed and then allowed to shift for itself. Frequent inspections should be made to see that all parts are in operating condition, that all bearing surfaces are properly lubricated, and that no moving parts are clogged with dust, dirt or grit. The vibration encountered in the average plant will frequently be sufficient to throw an instrument out of adjustment after a period of operation, and hence it should be made a point to keep a careful check on adjustments. Where a full complement of instruments is installed, it will be found profitable to invest also in some auxiliary equipment for calibrating and checking these instruments to see that they are kept in good condition. Such auxiliary equipment includes gage testers, thermometer calibrating equipment, platform scale, weighing tanks, etc.

As stated above, the information and records produced by the various instruments should be preserved and filed for future reference, because this information is frequently of very considerable assistance. For instance, if it is found necessary to install increased boiler or engine or turbine capacity. A glance over the past record of the plant will reveal the manner in which the plant has been operated, the average load and overload carried, the ratio of increase in requirements, the overall efficiency obtained, and the operating conditions which can be maintained would all be of tremendous value in deciding upon the size and type of new equipment which should be used.

For the purpose of preserving this data the Power Plant Log Book is a necessity. In it should be recorded all the data as developed by the various instruments and observations, the form and make-up of this book of course varying with every individual plant.

It is usually most convenient to run one log covering the boiler room operation, giving data as to the coal consumption, boilers in service, water consumption, steam pressures, feed temperatures, factors of evaporation, etc. Then another log can be kept for the engine or turbine room, showing the number of units in operation, the capacity developed, the steam pressure, oil and supplies used, the load factor, etc. These sheets can be laid out in such form that they can be brought together in a book face to face to give the record of the entire day's operation. Then at the end of the week or month a summary sheet can be worked out giving the factors, costs, etc., for the period in question.

In order to determine what instruments will make profitable investments, study the log with the idea of determining where the most serious losses occur and what can be saved by maintaining good conditions. This will give a good idea as to the amount of money that can be spent profitably for instruments, their care and upkeep. The instruments to install should indicate directly where the loss occurs and, to some extent, how much it is so that those in charge will have before them a continuous and immediate record of their work. If you have such instruments and the results are not up to standard, either the apparatus is at fault, or the men who operate it have not been properly instructed or do not follow instructions.

AN EXAMPLE of a variable standard and the confusion that arises from lack of general agreement is found in the perch used for measuring stone work. The perch is legally defined in some of the older states as 24¾ cu. ft., but standard is not universal, as in some states it varies from 16½ through 20, 22, 25 to 27 cu. ft. In other states it is defined as equivalent to 2200, 2500, 2700, 2800 and 3000 lb. The danger of using a variable standard like this is obvious, as contracting parties might have in mind entirely different conceptions of the value of the unit.—Machinery.

Water or Coal?

WITH increasing demands for coal due to intense manufacture to supply government needs; with transportation facilities taxed to the utmost; with labor shortage at the coal mines; with prices constantly rising, it would seem self-evident that wisdom demands the largest possible use of water power. This source does not exhaust our fuel beds, nor make demands on transportation lines or mine labor, and unless the energy available each minute is caught and utilized, it is gone beyond recall.

Secretary Lane states that some 35,000,000 hp. of water power is as yet unutilized in this country, and allowing 1000 tons of coal a year for 125 hp. the wasted energy of the water is equivalent to 280,000,000 tons of coal a year.

Besides the fuel store which might be saved, it is estimated that for each 1000 tons of coal mined, transported and consumed in generating power, the labor of 2.78 men is required for 1 yr., so that 738,000 men are required to handle the coal equivalent of the wasted water energy. Allowing that 40,000 men would be needed to care for the hydraulic plants, their use in place of coal power would release the labor of about 700,000 men to be employed in other pursuits. Both fuel and labor savings are of the utmost importance, especially under present conditions. Approximately, one man would be released for each 50 hp. of hydraulic power put into service.

As a matter of cost, while hydraulic power cost varies greatly with the cost of development and transmission, it is usually less than that of power developed from coal except in regions near the coal mines and remote from water power sites. And for many purposes, such as fixation of nitrogen from the air, and large electro-chemical processes, the tremendous amounts of power at low cost can only be obtained at points where large water powers are available.

We are buying 600,000 tons of nitrates a year from Chile, but the beds are showing signs of exhaustion, and ships are lacking for bringing it. Even if we could continue to get that amount, it is not enough. Belgium used 450 lb. of fertilizer to the acre each year and got yields of 158 bu. of potatoes, 32 bu. of wheat, 47 bu. of oats and 30 bu. of rye. England uses 152 lb. of fertilizer a year to the acre, but the United States uses only 28 lb. to the acre and gets average yields of 96 bu. of potatoes, 15 bu. of wheat, 29 bu. of oats and 16 bu. of rye. Experiments have proved that with larger amounts of fertilizer, 100 lb. to the acre a year, the crop yield in this country can be doubled. We need 18,000,000 tons of fertilizer a year to do it.

Phosphates are to be had in the southern and western states; we are making progress in getting potash from seaweeds and other sources, but nitrogen can come only from the air by electrical fixation, and the United States is the only large industrial country that is not already operating plants for this purpose. We need 12,000,000 hp. for nitrogen plants for fertilizers and explosives. Developing water power to this extent will cost $580,000,000, but the gain in crops would be $2,000,000,000 a year.

As an example of power cost reduction, the Chicago, Milwaukee & St. Paul R. R. on its electrified division of 450 mi. in Montana is paying $550,000 a year for electric power as against a former cost of $1,750,000 for coal and has released for transporting merchandise one-third of its equipment which was previously used for hauling that coal. Butte, Anaconda & Pacific R. R. has also reduced its costs to $96,000 a year for electricity as against $270,000 a year for coal.

A considerable portion of our undeveloped hydraulic power is in the western states, in forest regions where timber in great amounts is annually wasting to decay for lack of power to convert it into lumber. In 1915 we imported 400,000 tons of wood pulp, while sufficient logs to have furnished it were rotting on western mountain slopes.

Why are we not developing these resources? The answer is found in the present laws governing development of water power on government lands and navigable streams. Court decisions have established that at present a permit granted by any official for such development is revokable at the will of the Secretary of the Interior and without adequate compensation for expenditures made. Certainly nobody will invest in either stock or bonds of a water-power development company under such conditions.

Bills are now before Congress intended to overcome these difficulties, while safeguarding the interests of the country and the states. In the Senate, the Shields and Walsh Bills deal respectively with "dams across navigable waters and improvement of water ways" and with "development of water powers and the use of public lands in relation thereto" respectively. In the House, the Small Bill pertains to "construction, repair and presentation of public works on rivers and harbors."

Each sets the duration of the permit to private occupation of water power development at 50 yr., the United States having the right at the end of that period to extend the permit, to grant permit to another party or to take over the improvement, compensation being made in the last two cases for actual value of the property taken over by the new grantee or the government. In case of navigable streams, government engineers are to specify what locks, pools, fishways, etc., are to be provided at the time the permit is issued, and no liability is incurred by the grantee for work during the life of the permit other than that so specified. Other clauses provide for payment by the grantee for use of public land, for benefits derived from headwater or other government improvements, for control of charges, rates and service by commissions of the states where such service is rendered or, if that is not found possible, by the Interstate Commerce Commission. In rate making, the cost of construction of locks, pools, etc., for navigation is to be considered, but no allowance for value of rights under the permit. Diligence must be exercised in completing the improvement and in putting it into operation at such times as the Secretary of War may direct. Receipts for rents are to go to a special fund for maintenance of dams and navigation improvements.

Permits issued in the past may be changed to conform to the new law, but such change does not release the grantee from any lawful obligations already incurred. And no grantee can in any way be constructed or operated so as to form part of a trust or monopoly to limit output of electric energy or in restraint of trade. The bill does not apply to navigable streams wholly within a single state.

The Walsh Bill gives control of rates and service to the state in which the service is given or, if in more than one state, to the Interstate Commerce Commission. Grant may be given for the use of public lands by the Secretary of the Interior, suitable compensation to be required of which half goes to the state in which the land is located and half to the Reclamation Fund. No charge is made where a state or a municipality is making the development nor for powers of 25 hp. or under, used for domestic, irrigation or mining purposes. Safeguards are provided by inspection of accounts and by revocation of permit for breach of contract.

In the Small Bill, provision is made for establishment of water powers in connection with government dams already built, the control of grants to be by the Secretary of War and regulation of rates and charges to be by the states in which service is rendered or, in case of disagreement on interstate service, by the Interstate Commerce Commission.

In any case, construction is not to be begun until all plans have been approved by either the Secretary of War or the Secretary of the Interior, whichever has jurisdiction.

While experience may show the desirability of minor changes, the bills, as a whole are calculated to give a fair deal to both government and investors and to permit of making developments on a basis which will give definite knowledge of what the grantees are granted and are required to do. The power given to secretaries is somewhat arbitrary, but is not likely to be abused, and if any progress is to be made, somebody must be given power to grant permits.

The only opposition seems to be by those theorists who are opposed to getting anything done unless it is to be done their way. And meantime energy equivalent to over 10,000,000 tons of coal is going to waste each month. "The way to begin is to begin." If the waste is to be remedied, some basis must be established on which capital can be secured to make these developments, and the proposed bills offer such a basis.

CLEANLINESS is always highly desirable, especially in rooms where the product may become soiled if dirt is allowed to accumulate. It is, therefore, well to keep the shafting cleaned, and even polished. On account of the rotary motion of shafting and the resultant centrifugal force, dirt particles and oil are easily thrown off, the same as from pulleys. Such particles should never be permitted. It is not difficult to keep shafting clean and polished after it is once in that condition. It can be done from the floor with ease, by means of a long-handled wiper. Never stand on a ladder while doing such simple work. It is wasteful of time, dangerous and unnecessary.—The Canadian Manufacturer.

Orifice Discharges for Saturated Steam

CHART DESIGNED TO SIMPLIFY CALCULATION NECESSARY WITH USE OF ORIFICE DISCHARGE. BY L. A. A. KARL

A VERY accurate method to test steam flow in a pipe line is to use a circular orifice in the line. This can readily be done by inserting a steel plate with an orifice between two flanges and tapping in a steam gage on either side of the orifice.

The accompanying chart is designed to be used first to estimate the size of orifice to be used and second to determine the results of the test from the readings obtained.

In making tests of this kind, a few points are important to consider.

Where a relatively great drop in pressure through the orifice can be tolerated, the orifice should be so small that for most readings the absolute pressure on the low-

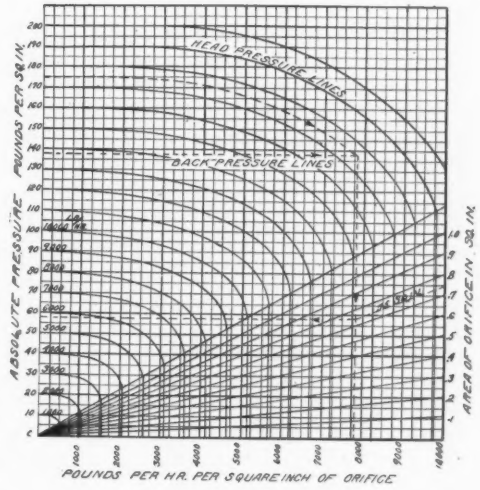

HEAD PRESSURE LINES
BACK PRESSURE LINES
ABSOLUTE PRESSURE POUNDS PER SQ. IN.
AREA OF ORIFICE IN SQ. IN.
POUNDS PER HR. PER SQUARE INCH OF ORIFICE

CHART FOR DETERMINING SATURATED STEAM DISCHARGE THROUGH ORIFICE

pressure side (the back pressure), should be less than 58 per cent of the absolute pressure on the high-pressure side (the head pressure). The area in the diagram below the upper slanting line covers this condition. When this condition exists, the well known Napier's rule holds and this rule is expressed by the formula:

$$W = \frac{A \times P}{70}$$

W = lb. of steam per sec.
A = area of orifice in sq. in.
P = absolute pressure in front of orifice in lb. per sq. in.

This rule is represented by the straight vertical lines in the diagram.

The limited use of this formula due to pressure conditions different from those assumed for it has greatly hampered the use of the orifice for practical testing purposes, as when the absolute back pressure of the orifice is more than 58 per cent of the head pressure the laws for flow of steam become very complicated and conse-

quently the calculations of such test results are very laborious.

The principal purpose of the accompanying chart is to make the orifice readily used by anybody under all conditions of back pressure.

The use of the chart is best illustrated by the following example. Suppose:

Orifice area is 0.75 sq. in.

Head gage reads 160 lb. per sq. in.

Back pressure gage reads 123 lb. per sq. in.

Atmospheric pressure (Barometer) is 15 lb. per sq. in. (30.5 in. of mercury, Hg.)

The head pressure to be used in the chart is then 175 lb. absolute.

The back pressure is 138 lb. absolute.

Note: Only absolute pressures are to be used in connection with the chart.

Start at 175 lb. on the left-hand scale and follow a curved path parallel to the head pressure lines until the back pressure line for 138 lb. is reached. This point in the diagram corresponds to test conditions.

Below this point on the bottom scale may be read 7800 lb. of steam per hour per sq. in. of orifice. Our orifice being 0.75 sq. in., the tested flow of steam is 0.75 × 7800, or 5800 lb. per hour. In order to avoid this last multiplication, the straight slanting lines have been put in the diagram. If, when going down from the point determined by the pressures, we stop on a slanting line corresponding to 0.75 sq. in. of orifice, we may read the flow of steam direct for this size orifice on the auxiliary left-hand scale as indicated in the chart.

In recommending the use of the orifice in conjunction with the chart presented for the measurement of steam flow, it is not my intention to infringe on the use of the steam flow meters, but I would like to say that when the orifice is properly installed and when appreciable pressure drops can be tolerated, it will give results with very small errors (1 to 3 per cent). This of course assumes correct gages for reading the pressure.

It is a sad fact that in many power plants and factories the engineer cannot secure a flow meter from the management, but with two gages, a gage tester and a piece of steel plate he can do fully as good work.

In order to secure good results the upstream edges of the orifice should be well rounded to avoid contraction of the jet when entering the orifice.

In orifice measurement where great care is necessary, the diameter of the hole is calipered when at the temperature at which it is used during the test or the cold diameter is calipered and the correction due to expansion is calculated. For ordinary testing, such accuracy is not necessary, as other errors due to commercial steam gages, etc., would easily exceed any such error. The chart is only of such accuracy as is required by ordinary testing and is not recommended for any other purpose.

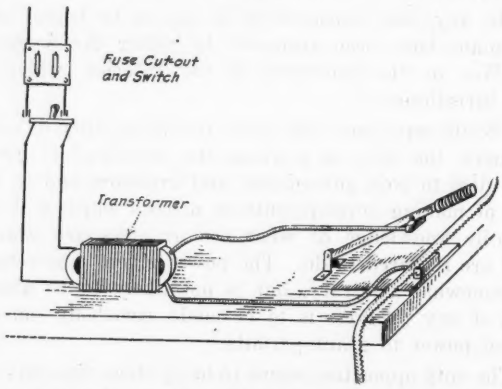
The orifice formulas are based on the flow of steam from zero velocity, i.e., from a large tank. In order to approximate this condition, a pipe line in which an orifice is to be used should have a diameter at least 10 times larger than the diameter of the orifice used though no very great errors are made even at five diameters. If the pipe line is too small to accommodate the orifice, a few feet of it may be taken out and replaced by a larger diameter pipe.

The writer has used this chart to great advantage in numerous tests and would say that where a steam meter can be had it will pay to check it up at intervals with an orifice test in the same pipe line.

Welder for Repair Work

APPARATUS MADE BY REPLACING SECONDARY WINDING OF 1-KW. TRANSFORMER WITH FEW TURNS OF HEAVIER WIRE. BY H. S. RICH

SMALL repair work may easily be performed with the practical welder shown in the accompanying illustration, which is made by rebuilding a 1-kw. 220-v. transformer. The secondary winding was removed and replaced by one wound with 3 or 4 turns of about No. 4 stranded slow-burning wire so as to deliver from 30 to 40 amp. at 5 to 10 v. A 25-amp. knife switch fused for 15 amp. is used on the primary line. The secondary flexible leads should be carried to the welding vise, as shown in the illustration, where they are tipped with large copper lugs and securely screwed to two copper blocks about 2 in. long by 1 in. square on the ends. By connecting directly to the copper electrodes the voltage is not lowered by resistance. Large electrodes



METHOD OF USING WELDER IN REPAIRING BROKEN SAW.

are used so that the heat of the welding arc will not damage them.

The lower electrode is screwed to the bench, which is first covered with 1 sq. ft. of ⅛-in. asbestos board. The upper electrode is bolted to a flat iron bar 18 in. long, 1 in. wide and 0.25 in. thick. A wooden handle is riveted one-half to each side, and then covered with 2 or 3 layers of friction tape. The object to be welded as well as a piece of hard silver solder must be in place before closing the secondary circuit. The joint to be welded is placed on the lower electrode and the lever carrying the upper electrode lowered. The circuit should be kept closed only a few seconds with a heavy hand pressure on the lever. After opening the circuit, the joint should be filed and cleaned.—Electrical World.

LABOR IS a necessity to human existence; being such, it is obvious that under natural conditions it should be a pleasure, not a penance.—Coast Seamen's Journal.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Single-Phase Motors

DISCUSSION OF THE THEORY OF OPERATION OF THOSE TYPES MOST GENERALLY EMPLOYED IN INDUSTRIAL SERVICE. BY GORDON FOX

THE single-phase induction motor, the most commonly used motor, is similar in many respects to its polyphase prototype; its stator is practically identical, a polyphase winding being ordinarily supplied. The rotor is of the squirrel-cage type. A centrifugal clutch is usually provided which disconnects the rotor from the shaft while starting and enables it to accelerate without load until fairly well up to speed.

The action of the single-phase induction motor is somewhat different from that of the polyphase machine. In the latter, a revolving magnetic field is set up by properly located stator windings carrying currents out of phase with each other. In the single-phase motor, it is impossible to create such a rotating field through any arrangement of stator windings, since only a single pulsating current is available.

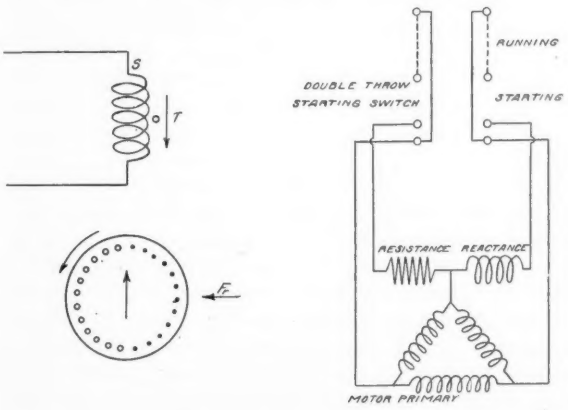


FIG. 1. DIAGRAM OF SINGLE-PHASE INDUCTION MOTOR
FIG. 2. DIAGRAM OF CONNECTIONS SHOWING USE OF SPLIT-PHASE STARTER

If a polyphase motor, while running, has one phase disconnected, it will continue to run, but will carry only about 70 per cent of its rated load. This action may be quite simply discussed. In a 2-phase motor wound with 2 poles per phase, allow one phase to be disconnected. The field set up by the current in the remaining phase does not rotate but merely reverses, passing through a series of values. The rotor conductors, revolving across this field, have generated in them a voltage which varies as the field. This voltage is in phase with the reversing magnetism, and sets up currents in the squirrel cage rotor, which also alternate through a series of values. The disposition of this current in the various rotor conductors is such that the magnetizing effect is at right angles to the main field. The rotor currents which set up this field lag 90 deg. behind the voltage generated in the rotor. It is thus evident that this cross field is 90 deg. out of phase with the main field, which corresponds to conditions occurring in a 2-phase motor. The main field and the cross field of the single-phase induction motor combine to produce a rotating field similar to that of the polyphase motor. When the rotor is at rest, however, there can be no revolving field since the rotor conductors cut no magnetic lines, have no generated current and have no cross field.

Figure 1 should make clear the action of the single-phase induction motor. Coil S represents the distributed stator winding. A magnetizing current flows through this coil and sets up a vertical flux, which induces a voltage in the rotor through transformer action. Also, due to rotation, a voltage is in the rotor in phase with the vertical flux. And as the induced voltage is in quadrature with the vertical flux, the two voltages are thus in quadrature with each other. The generated voltage sets up currents so disposed as to cause a horizontal field Fr. The induced voltage sets up currents so disposed as to oppose the vertical field, just as in a transformer. The horizontal field and the induced current are in phase with each other. They therefore react

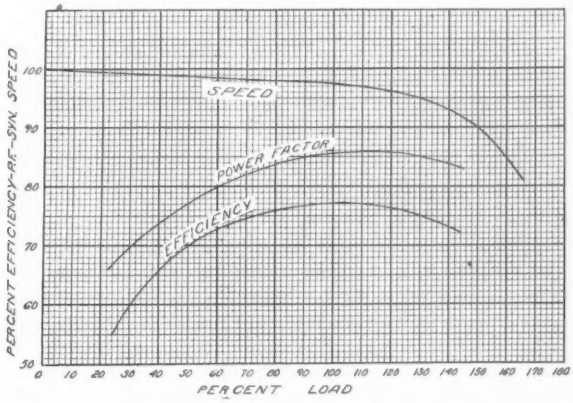


FIG. 3. CHARACTERISTICS OF SINGLE-PHASE INDUCTION MOTOR

to produce torque. The vertical field set up by the induced currents, influences the primary magnetism and, through transformer action, sets up an equal and opposite load current in S. The influence of the load is thus transferred from rotor to stator. With the motor at rest, there is no generated voltage in the rotor, hence no field Fr and consequently no torque.

The revolving field of the single-phase induction motor is the result of the combined action of stator and rotor fields. The magnetizing force required to set up the stator field is similar to that of one phase of a polyphase motor; the magnetizing force required to set up the rotor's cross field is of like magnitude. The cross field magnetizing current must come finally from the stator winding connected to the mains. The magnetizing current drawn thus corresponds to that taken by the two phases of a 2-phase stator winding and is about twice that taken by one phase of a 2-phase motor. The low power factor characteristic of the single-phase induction motor is thus explained.

Torque of an induction motor is proportional to the product of rotor amperes and field flux, which latter factor in a polyphase induction motor is practically the same at all loads and the maximum torque is independent of the slip. In a single-phase induction motor, one portion of the field is controlled by the stator while the other portion is set up by the rotor current, which is due to the cutting of flux and is therefore proportional to the speed. The resultant revolving field thus varies with the speed. The maximum torque must therefore also vary with the speed. With increased slip the maximum torque is lessened. The amount of slip depends largely upon rotor resistance. High rotor resistance in a single-phase induction motor would thus have the effect of lowering the pull out torque. For this reason, single-phase induction motors are always of the squirrel-cage type.

It has been mentioned that the single-phase induction motor has normally no torque at starting. The most common method of bringing motors of this type up to speed is by approximating polyphase action through use of a "split phase" starter. When this method is employed, the motor is wound polyphase and is connected as shown in Fig. 2, so that out-of-phase voltages are impressed at its terminals. A fairly strong revolving field is thus set up which suffices to start the machine. When the motor has attained nearly synchronous speed, the starting device may be cut out and the motor will continue to operate as a single-phase machine. Two of the three leads will then remain in use. Although the starting torque developed through the use of a split-phase starter is not large, the current flow is quite heavy. Motors of this type are commonly arranged with the rotor revolving freely on the shaft and a centrifugal clutch is provided which connects the rotor to the shaft at a speed slightly below synchronism. In this manner, the motor is enabled to start without load, yet to accelerate a load after the condition of running torque has been reached. During the period of acceleration there is a certain amount of slippage in the clutch. Motors of this type will accelerate against about 150 per cent full load torque with a current input of about 250 per cent full load rating; they will carry about 75 per cent overload before the clutch slips.

Torque of the single-phase induction motor varies as the square of the applied voltage, being in this respect similar to the polyphase machine. The efficiency of the single-phase motor is lower than that of the polyphase type. The exciting current is greater, which adds to the primary copper loss, as does also the rotor exciting current. Characteristics of a motor of this type are shown in Fig. 3. The speed is seen to be quite constant under ordinary loads, dropping markedly with heavy overloads. The maximum torque is little more than 150 per cent full load value, due to clutch slippage. The power factor is rather low at all loads, being better the heavier the load. The efficiency is fair.

Single-phase induction motors find a considerable field of application in the small sizes for use where polyphase current is not available, as in residence districts or where small installations will not justify polyphase distribution. The induction motor in fractional horsepower sizes has been highly developed for domestic applications. The low power factor and heavy starting current are often objectionable features as being detrimental to voltage regulation. Since motors of this type are generally connected to lighting mains, this feature is important. The inflexibility in speed and control features is a drawback to this type of machine in many instances. For constant speed drives where starting is infrequent and starting load light and where voltage regulation of the line is not important, this type of motor offers advantages in simplicity and ruggedness.

The shunt-wound direct-current motor has excellent characteristics and a wide field of application, and the question may well be raised why a single-phase alternating-current motor is not built similar to the direct-current shunt type. The main reasons may be briefly set forth. The field of such a motor, when connected to an alternating current line, would have high impedance and the current through it would lag decidedly behind the impressed voltage. The field set up would also lag 90 deg. behind the line voltage. The armature of such a machine would have comparatively little inductance and the current through it would be nearly in phase with the line voltage. Armature current and field flux react to produce torque. In a shunt-wound alternating-current motor, the armature current and field flux are nearly in quadrature, the armature current being small when the field flux is maximum and vice versa. The consequent torque is therefore small. A motor of this type must be very large for its rating and its efficiency would be low, and due to the high inductance of the field circuit, the power factor would be very low. Commutation would be poor because of heavy induced currents in the brushes which short-circuit portions of the winding. These features combined render the shunt-wound alternating-current motor entirely impractical.

The series-wound motor is much better suited for operation with alternating current. If the two line terminals of a direct-current series motor be interchanged, the rotation of the motor is not affected, as the armature current and the field current reverse simultaneously so that the torque remains in the same direction regardless of the polarity of the terminals.

It is evident, therefore, that with a few minor changes the motor will operate upon alternating current. It is necessary to laminate the entire magnetic field circuit to eliminate the eddy currents which would be excessive in solid poles and yokes such as are used in direct-current motors. The field windings of a series motor necessarily have considerable inductance, which tends to lower the power factor and to allow the voltage at the armature terminals to drop off as the load increases. This action affects the speed regulation and lowers the pull out torque. The choking influence of the field is proportional to the field flux and the square of the number of turns in the field winding. It is desirable that the inductance be maintained as low as possible for reasons already set forth. A low value of field flux contributes to low inductance. A weak field, however, is conducive to small torque and to counterbalance the weak field it is necessary to provide a large number of armature conductors. An armature with many conductors has comparatively high magnetizing influence which would cause great distortion of a weak field. This is overcome in some types by compensation. In motors not compensated, but a moderate number of armature conductors are used and little torque is developed. The motors are operated at very high speeds, however, thus securing considerable output. Field inductance may be reduced by restricting the number of field turns. Low flux density, small total flux, short air gap, a large number of poles with short magnetic circuits and high quality iron may all contribute to reduce the field turns required.

The alternating-current series motor is shown diagrammatically in Fig. 4. In this machine the field coils set up a reversing flux, F, in the direction indicated. The armature current is so disposed as to set up a cross field along the axis, R. The armature current and the field flux, F, are in phase with each other and react to produce torque. The flux, R, has no useful function. It distorts the field and lowers the power factor, since magnetizing current is required for its maintenance. A counter voltage is generated in the armature conductors, due to rotation in the fields F and R, the action being similar to that in a direct-current motor.

It should be noted that the reversing flux, F, induces a voltage in those armature conductors under its influence. Some of these conductors are short-circuited by the brushes, and as a consequence, due to transformer action, a short-circuit current is induced in these coils. Interruption of this current when a bar passes out from under a brush leads to serious sparking, an action not present in direct-current motors except to a minor extent in case of widely fluctuating loads. In alternating-current machines the effect is lessened through the use of low flux values, by restricting the number of armature turns between commutator bars and through use of a large number of armature coils, each having few turns, in some cases only a single turn.

The series alternating-current motor has a characteristic similar to that of its direct-current prototype. The field strength varies directly with the load and the speed consequently changes inversely as the load. The starting torque is good. The power factor is good at light loads with weak field and decreases with increase of load. At starting, the power factor is rather low. The motor may be built with projecting pole pieces as in direct-current machines or the winding may be distributed in the bore of the stator as in an induction motor. Simple series motors are most extensively used in comparatively small sizes, ¼ hp. or less at very high speeds. The high-speed ratings are due to the weak field requirement together with the need of armatures with few conductors, as already stated.

Compensation greatly improves the characteristics of series alternating-current motors except in the small high-speed ratings. The compensated series motor is shown in Fig. 5. Here another winding having a magnetizing influence approximately equal and opposed to that of the armature has been introduced. The cross field, R, is thus neutralized. Commutation is improved, since distortion of the main field is eliminated. Power factor is raised, since the magnetizing current to set up field R is no longer taken. The compensating winding is most effective if it is distributed over the stator bore in a way similar to the distribution of the armature winding over the armature. Each element of armature

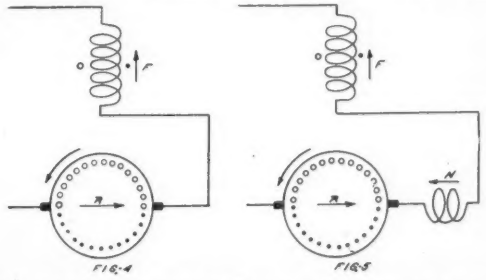


FIG. 4. DIAGRAM OF CONNECTIONS OF SIMPLE SERIES MOTOR
FIG. 5. DIAGRAM OF CONNECTIONS OF COMPENSATED SERIES MOTOR

magnetizing influence is then neutralized and all field distortion prevented. Compensating windings may be placed upon projecting pole pieces, may be located in slots in the main pole faces or they may be distributed in a smooth bore stator and so arranged that the magnetizing influence is 90 magnetic degrees from the main field. The compensating winding is similar to the interpole of a direct-current motor except that the influence is distributed instead of being concentrated over a narrow zone.

(To be continued)

Oil Burners for Emergency Loads

Auxiliary Equipment for Break-Down and Peak-Load Service

ACCORDING to an article in the Electrical World, 4 auxiliary oil burners have been provided for each of the boilers installed at the Dutch Point station of the Hartford Electric Light Co., to carry unexpected peaks such as might occur if any boilers or coal-handling apparatus become incapacitated. The boilers installed at this plant are 1250-hp. Bigelow-Hornsby units. Three are equipped with Riley underfeed stokers and the remainder with Taylor stokers.

As shown by the accompanying drawings, the burners are installed on the side walls of the furnaces in such

a manner that they may be inserted in rectangular openings and the flames directed across the furnace. Being connected with the oil and steam supply by swivel joints, the burners can be folded up against the furnace wall when not in use and the wall openings closed by doors hinged along the top. The openings are about 4½ ft. above the floor level and 3 ft. apart, the one nearest the stoker being 30 in. from the front wall.

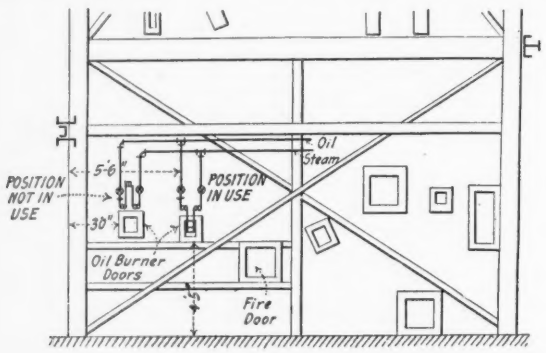


FIG. 1. POSITION OF BURNERS ON BOILERS

Sufficient space is provided around each burner to admit the air required for combustion.

The oil and steam supply pipes approach the openings vertically and terminate in swivel joints about 14 in. above the center lines of the furnace-wall opening. At these joints they are connected with pipes that hold the burner-nozzle tip almost even with the inside wall of the furnace when in position for operation. The pipes are bent and connected in such a manner that the nozzle and pipes connecting with it may turn about an axis through the two swivel joints. Globe valves are provided in both pipes leading to the burner, but the oil flow is regulated by an additional valve installed below the globe valve. Since no auxiliary equipment, such as

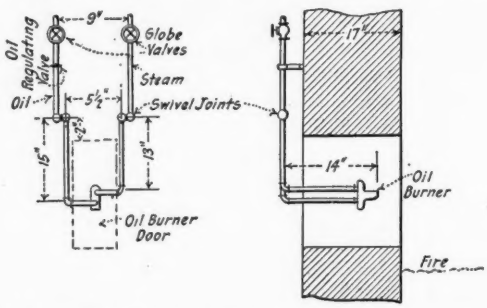


FIG. 2. NOZZLE CONNECTIONS TO STEAM AND OIL PIPES

baffles to protect the grates, is required with the equipment, it does not hinder normal operation when the underfeed stokers are used. In one case a brick checker work was built over the grate, however, to ascertain its effect on oil-burner operation. With this temporary addition, the oil burners were able to carry 200 per cent of boiler rating.

Static Transformers as Boosters

STANDARD DISTRIBUTING APPARATUS MAY BE EMPLOYED AS A CONSTANT BOOSTER; VOLTAGE RELATIONS; PRECAUTIONS TO BE OBSERVED. BY F. S. FLETCHER

THE booster transformer, which, by the way, may be used to buck instead of boost by simply reversing one winding, consists of one winding connected in shunt across the line while the other winding is connected in series with one side of the line. Different results will be obtained whether the primary or shunt winding is connected between the source of supply and the series or secondary coil or whether it is connected between the secondary coil and the load, a fact that may be sometimes utilized to good advantage. To make the matter clearer, suppose a standard 10 to 1, 2000-v. distributing transformer is used. With the primary connected as shown in Fig. 1-A, namely between the source of supply and the booster secondary, the boost is 200 v. and the total voltage is increased from 2000 to 2200. If instead the primary is connected "ahead" of the secondary as shown in Fig. 1-B, which is between secondary and the load, a higher boost is effected by an amount equivalent to the voltage of the secondary expressed as primary voltage. The voltage on the boosted side would then be 2222 v. instead of 2200; the extra 22 v. may often be very serviceable, especially since it is so easily obtained.

It is quite a simple matter to calculate the effect of connecting the primary of the booster between the secondary winding and load instead of between source of supply and secondary winding, and thus determine beforehand the effect of the change. For example, suppose the transformer is a standard 2000-v. unit, with a ratio of 10 to 1, that is with a secondary of 200 v. If X represents the resultant voltage on the load side of the booster, when connected between booster and load, then the increase of voltage due to the secondary winding is given by $X/10$. The total boost is then

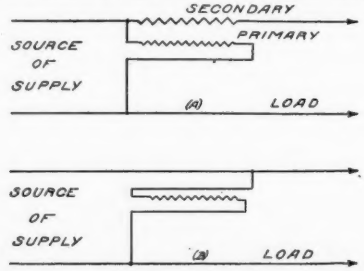


FIG. 1. (A) PRIMARY CONNECTED "BEHIND" BOOSTER. (B) PRIMARY CONNECTED "AHEAD" OF BOOSTER FOR ADDITIONAL VOLTAGE INCREASE

expressed by X equals 2000 plus $X/10$ whence $X10$ minus X equals $9X$ equals 20,000, and, therefore, X equals 2222.

The boost is thus seen to be from 2000 to 2200 or 2222 v., according to which connection is used.

BOOSTER TRANSFORMERS ON 3-PHASE CIRCUITS

IT IS GENERALLY understood that by connecting three single-phase transformers in star instead of delta in

a 3-phase circuit, for a constant supplied voltage the transformed voltage will be increased over that corresponding to the transformer ratio by $\sqrt{3}$, or 1.732, with the same stress between turns. In view of this fact, it might be taken for granted that in arranging 3 transformers to act as boosters in a 3-phase circuit a higher boost would be obtained by connecting the shunt windings in star instead of in delta. In actual fact the reverse is the case, that is, by using a delta connection, a higher boost is made possible. The method of connecting three transformers in star and delta is shown in Fig. 2, and the corresponding voltage diagrams in Fig. 3. It is seen that if the transformers have the standard ratio of 10 to 1 then by connecting the booster transformers in star the percentage boost is 10 per cent, whereas connecting them in delta gives 15 per cent. By connecting the primaries between load and booster, as already pointed out, an intermediate voltage can be obtained with the star connection and a voltage in excess of 15 per cent with the delta.

Capacity of Booster Transformers

The capacity of the booster in all cases is governed by the capacity of its secondary winding, that is the

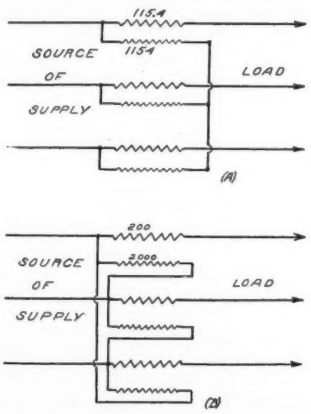


FIG. 2. THREE SINGLE-PHASE TRANSFORMERS CONNECTED IN STAR (A) AND IN DELTA (B) AS BOOSTERS IN 3-PHASE CIRCUITS

winding in series with the circuit, which is the low-voltage winding. For example, if the circuit carries 50 amp., then the booster must be a transformer whose low-voltage coil is capable of carrying not less than 50 amp. In the above instance the booster would require a capacity of 10 kv.a., while the actual load was 100 kv.a.

If burnouts are not to occur, it is important not to forget to keep the capacity of the booster transformer on the safe side. This is even more important where the primary is connected on the "boost" side since the impressed voltage on the transformer primary is then higher than it is when connected on the other side; moreover, it is also higher than the voltage for which the transformer was designed. This means that the core or iron losses will be higher, hence also the overall heating. Still further increasing the heating, and thereby tending to lower the capacity of the booster, is the fact that with the ordinary transformer the load does not persist continually, that is the load-factor is not commonly 100 per cent, while with the booster the high voltage exists so long as the line is alive, although of course the load may vary.

Need for Proper Insulation

In using ordinary static transformers as boosters there is one other important thing to remember. That is, that the service is other than that for which the apparatus was primarily designed, and if neglected the insulation may be subjected to excessive voltage or dielectric stresses. The standard distributing transformer is designed for about 10,000 v. between high-voltage coils and case, while the 220-v. or low-voltage coils are designed to withstand a test pressure of 4000 v. for one minute between coils and core and case. When used as a booster the secondary coils are raised about 2000 v. continuously above ground instead of only during the application of a test voltage. Such sustained voltage may cause breakdown of the secondary. The remedy is to insulate the transformer case from earth. When used upon a pole the insulation occurs automatically, since the pole acts as the insulating medium.

Transformer vaults and houses are coming into increasing use now, however, and in such cases the transformers are usually placed upon the floor. Where transformers are used as boosters it is safer, as regards the apparatus and workmen, to place them upon a slightly raised platform of dry wood. In any case where sta-

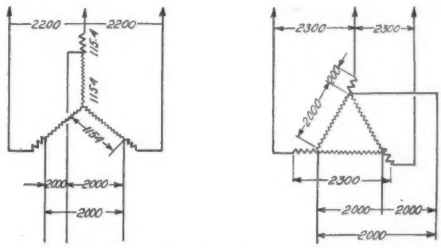


FIG. 3. BY CONNECTING BOOSTER TRANSFORMERS IN A 3-PHASE CIRCUIT IN DELTA INSTEAD OF STAR A FURTHER GAIN IN BOOST OF 5 PER CENT IS OBTAINABLE

tionary apparatus, such as the oil-cooled transformer, is operating at full load it increases its current-carrying capacity to raise them above the floor level so that air is able to circulate underneath them, thus further assisting the circulation of air and the dissipation of heat.—Electrical Review.

British Columbia comprises 372,640 sq. mi. The population is less than 500,000. There is nearly 500,000 hydro-electric horsepower planned for or developed. But when we come to available water power in that province, the figures are no less than 3,000,000.

In Norway 400,000 hp. is used to fix nitrogen, and before the war, Norwegian ships sailed around Cape Horn with loads of fertilizer for the Pacific Coast. The raw materials to make it are air and lime. The additional requirements are power and plant and the men to operate it. All the way along that beautiful British Columbian and Alaskan coast there is power galore and the question seems fair whether, when the war is over—if it ever is—and the world gets straightened out a little—if it ever does—nitrogen fertilizer will be made there for the Pacific Coast and Eastern Asia. Or will Norwegian ships continue to bring it to the American West?

Cost of Tracking Systems for Central Stations

Detailed Costs of Side Tracks. By John D. Morgan

As everyone knows, every central station or power plant that uses coal as a fuel demands more or less tracking facilities, the amount varying with the location and coal storage capacity. In order to convey the relative cost of tracking, I have prepared Table I.

In the average engineering department of central stations there is generally no one who is sufficiently familiar with tracking costs to prepare a real estimate of the approximate cost of the trackage; this results in the amount of money appropriated being largely a guess. To aid the average engineer in preparing a reasonable estimate, the following data has been worked up:

Labor Data for Track Construction

1st—Dirt excavation or track grading.

A. Plough with 2 men and 2 horses.

Nature of Soil	Cu. yd. loosened per hour
Clay	10 to 8
Heavy loam	25 to 20
Light soil	50 to 40
Sandy soil	100 to 80

B. Man with a pick.

Nature of Soil	Cu. yd. loosened per hour
Clay	1.4 to 1.0
Heavy loam	2.5 to 2.0
Light soil	4.0 to 3.5
Sandy soil	6. to 5.

C. Loading dirt into cart.

Nature of soil	Cu. yd. per man per hour
Clay	1.5 to 1.3
Heavy loam	1.7 to 1.5
Light soil	2.0 to 1.7
Sandy soil	2.4 to 2.0

D. Hauling and dumping with horse and cart of ⅓ cu. yd. capacity and half time of one man.
5 min. per trip of 100-ft. lead.
6 min. per trip of 200-ft. lead.

E. Spreading earth at dump.
Dry earth—Cu. yd. per hr. per man:
Cart dump, 7.5. Wagon dump, 10.0.
Wet earth—cu. yd. per hr. per man:
Cart dump, 5.0. Wagon dump, 7.5.

F. Drag scraper with 2 horses and 1 man.
4.5 cu yd. per hr. per 100-ft. lead.
3.0 cu. yd. per hr. per 200-ft. lead.

G. Moving dirt by wheelbarrow consisting of loading, wheeling and dumping.
1.71 cu. yd. per man per hour per 100-ft. lead.
1.19 cu. yd. per man per hour per 200-ft. lead.

2nd—Track laying.

A. Tie placement.
4 men—100-ft. lead. 4 to 5 ties per hour.

B. Tie plate placement.
2 men—25 plates per hour.

C. Rail placement.
70-lb. rail:
6 men @ 100-ft. lead will lay 264 ft. per hour.
85-lb. rail:
8 men @ 100-ft. lead will lay 264 ft. per hour.
100-lb. rail:
10 men @ 100-ft. lead will lay 264 ft. per hour.

D. Track laying.
15 men will lay 8 ft. per hour of curved track.
15 men will lay 31 ft. per hour of straight track.

E. Spiking.
2 men will drive 18 to 24 spikes per hour.

F. Tamping and surfacing track.
15 men will do 15 ft. of track per hour.

G. Placing 15-ft. guard rail.
2 men—1½ hr.

H. Switch placement.
Placing switch timber—4 men will lay 3 timbers per hour.
Spiking and setting side plates—2 men, 20 hr.
Setting up switch—2 men, 10 hr.
Adjusting switch—2 men, 2 hr.

I. Survey and drafting per mile of track.
3 men (transit man, rod man and stake man)—46½ hr. in field.
Office work—Transit man (doing his own notes)—24 hr., or draftsman, 30 hr.

Below is given prices f.o.b. mill of various supplies used in track construction as of Jan. 1, 1916:

Slide plates ..... 50c each
Tie plates ..... 25c each
Fish and angle plates..... 1.7 c per lb.

TABLE I. RELATIVE COST OF TRACKING

Plant Size in KW.	Length of Track Ft.	Rail Size Lb.	Unit Cost of Material	Unit Cost of Freight	Unit Cost Unloading and Cartage	Unit Cost of Labor	Total Unit Cost	Total Cost
3525	2110	60	$1.36	$0.0637	$0.0405	$0.8014	$2.2656	$4780.40
1280	730	60	1.4194	0.0770	0.0216	1.0017	2.5197	1839.88
4200	360	70	1.809	0.1039	0.0292	0.9533	2.8954	1042.36
800	200	70	1.8796	0.0991	0.0742	0.9185	2.9715	594.29
3000	1110	70	1.4563	0.0746	0.0292	0.7444	2.3045	2558.00
1600	550	70	1.6672	0.1452	0.0292	0.8564	2.698	1483.93
10000	700	70	1.6586	0.1036	0.0292	1.1507	2.922	2045.46
5950	360	70	2.6618	0.1304	0.0292	0.6722	3.4937	1257.72
18500	1350	80	2.1485	0.0756	0.033	1.0769	3.3343	4501.29
1950	430	90	2.638	0.1557	0.0375	0.7362	3.5674	1533.93
75000	9307	90 70	2.0612	0.0853	0.0338	0.9079	3.0885	28741.95
2140	243	100 60	1.6385	0.099	0.465	0.9513	2.7353	664.69
24350	775	100 85 70	2.7699	0.1074	0.0691	0.743	3.6894	2859.26
8900	1594	100	2.4735	0.0939	0.0678	1.2152	3.8504	6137.62

TABLE II. UNIT COSTS PER FOOT FOR TRACK AT VARIOUS PLANTS

Capacity of Plant K.W.	Unit Cost Per K.W. of Plant	Unit Cost Per K.W. of Tracking	Tracking Cost in % of Total Cost
800	$78.20	$0.74	0.95%
1280	147.10	1.44	0.98%
3525	175.70	1.35	0.77%
2140	149.40	0.31	0.21%
3000	146.35	0.85	0.58%
4200	146.70	0.25	0.17%
5950	71.40	0.21	0.29%
8900	122.70	0.69	0.56%
17900	104.70	0.16	0.15%
1600	83.10	0.93	1.10%
10000	85.34	0.20	0.23%
18500	53.15	0.24	0.45%
75000	57.50	0.38	0.66%

Spikes	2.85c per lb.
Guard rail, 15-ft. length, 70-lb.	$ 8.60
Guard rail, 15-ft. length, 80-lb.	9.85
Guard rail, 15-ft. length, 85-lb.	10.50
Guard rail, 15-ft. length, 90-lb.	11.10
	Each
No. 5 frog, 70-lb.	27.25
No. 5 frog, 80-lb.	29.50
No. 5 frog, 100-lb.	34.25
No. 5½ frog, 90-lb.	33.00
No. 7½ frog, 70-lb.	33.30
No. 4 frog, 60-lb.	22.20
No. 4 frog, 70-lb.	24.80
No. 4 frog, 80-lb.	26.80
No. 4 frog, 90-lb.	28.70
No. 6 frog, 60-lb.	26.40
No. 6 frog, 70-lb.	29.50
No. 6 frog, 80-lb.	32.20
No. 6 frog, 85-lb.	33.60
No. 6 frog, 90-lb.	34.90
90° 80-lb. crossover	300.00
60° 80-lb. crossover	350.00
Bumping posts	75.00
Automatic switch stands	$12.00 to 17.00
Ground lever switch stand	5.00
Ground lever switch stand with spring	7.50
	Per pair
Point rails, 15 ft. long, 100-lb.	$22.80
Point rails, 15 ft. long, 90-lb.	21.20
Point rails, 15 ft. long, 85-lb.	19.60
Point rails, 15 ft. long, 80-lb.	18.40
Point rails, 15 ft. long, 70-lb.	17.00
Point rails, 15 ft. long, 60-lb.	15.60
	Per ton
Open hearth steel rails, carload lots	$37.00
Open hearth steel rails, less than carload	39.00
Bessemer steel rails, carload lots	35.00
Bessemer steel rails, less than carload	37.00

Table II shows the unit costs per foot of track for several different power stations' tracking systems.

Using the Slide Rule

APPROXIMATE CANCELLATION AS A MEANS OF DETERMINING LOCATION OF DECIMAL POINT. BY A. EDWIN WELLS

NEARLY all instruction books treating the slide rule fail to give rapid methods for locating the decimal point when using this instrument. Once this difficulty is overcome, the slide rule is of great importance.

In practically all lines of engineering work, the numbers composing the various elements of a problem will not consist of more than 4 or 5 figures, and accuracy will not be desired to more than 4 or 5 places. For example, it is unnecessary to calculate the size of a pulley to hundredths of an inch; neither is it customary to compute draft to thousandths of an inch. Hence, the slide rule, if properly used, is an excellent time saver.

The first point to note is that all problems should be brought into the form of (1) in the accompanying calculations. Next, the decimal point should be located by approximation. Suppose we had resolved a problem into the form shown at (2). The decimal point can be accurately located by what is called approximate cancellation.

Taking the problem at (3), we find that 93.3 is divisible into 97.5 approximately once; 22 into 815 approximately 40; 78.7 into 174.5 twice, and 0.755 into 3.455 about 4. Hence, X should equal about 20. Therefore, we know that our answer should be about 20; it cannot be 2 or 200. Our approximation has given us an idea of the answer, as well as the correct number of places to the left of the decimal point.

We shall now proceed to solve on the slide rule. Set hair line on 9.75 on D scale; set slide to bring 9.33 of C scale under hair line; move runner to 8.15 on C scale; set 22 of C scale under it; runner to 17.45 on C scale; set 7.87 under it; runner to 7.55 on C scale; set 3.455 under it, and read answer under 10 of C scale as 18.76. This shows us that our approximation was only 1.24 out of the way.

Any number of tests will convince one that the approximate method accurately locates the decimal point. If approximation gives an answer of about 9.0, it is evident that the answer might be 10 or 11. If such proved to be the case, it would be absurd to assume only one figure to the left of the point and call the answer 1.1. As approximation has shown that the answer is about 9, then we know that the correct answer is 11, if these figures were finally obtained from the rule.

Long fractions like the one above, are often encountered when calculating the drafts of various machines, and gear trains. One can go through the problem by approximation, proceed through the operation of the slide rule twice, and still have completed the problem in considerably less time than would have been taken, had logarithms or long hand been employed.

Another practical problem might be as follows: A shaft, revolving at 150 r.p.m. has an 18-in. pulley on it which is to drive a second shaft at 350 r.p.m. Find size of pulley on the latter shaft by means of the solution shown at (B) which indicates that an 8 or 7¾-in. pulley would in all probability be used.

METHODS OF EMPLOYING APPROXIMATE CANCELLATIONS FOR LOCATION OF DECIMAL POINTS

(A)

$$X = \frac{\text{Numerator}}{\text{Denominator}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$X = \frac{97.5 \times 815 \times 174.5 \times 0.755}{93.3 \times 22 \times 78.7 \times 3.455} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$X = \frac{\overset{1}{\cancel{97.5}} \times \overset{40}{\cancel{815}} \times \overset{2}{\cancel{174.5}} \times \cancel{0.755}}{\underset{4}{\cancel{93.3}} \times \cancel{22} \times \cancel{78.7} \times \cancel{3.455}}$$

$$= 20 \text{ nearly} \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

(B)

Speed of driving shaft = 150 r.p.m.

Diameter of driving pulley = 18 in.

Speed of driven shaft = 350 r.p.m.

Diameter of driven pulley = X

Solution: - 18 times 150 = X times 350

$$X = \frac{\overset{70}{\cancel{18} \times \cancel{150}}}{\underset{20}{\cancel{350}}} = 7 \text{ approximately}$$

By slide rule, X = 7.725 in.

This approximate method of finding the answer, and accurately locating the decimal point, is the most rapid method I have encountered, and every engineer will find it adds to the value and use of the slide rule.

Lubricating Oil Density*

By W. F. Schaphorst

IT is unfortunate that such a term as Baumé is used in connection with determining the density of an oil. It means very little to the average man. A "drummer" once came to me with his sample case full of small bottles of oil. He wanted me to buy his brand of oil. He took out one of his bottles, placed on a table, put a hydrometer in it and exclaimed: "There! How's that?" I said "How's what?" And thereupon he tried to explain to me that the little hydrometer floating in his oil proved beyond a shadow of doubt that his oil was a superior variety. I couldn't "see it," of course, and didn't buy, and since that incident I have learned that the gravity test doesn't amount to anything anyway.

The hydrometer test is of value principally for identifying oils. For example, if you have been using a certain brand of oil for some time and you want to continue its use, just measure its density by means of a hydrometer and make note of it. Then the next time you buy oil that is claimed to be the same as the last, you can at least easily check up its density. The density test is the easiest of all, especially if you have a hydrometer.

Coming back to the word Baumé, perhaps the reader would like to know how to convert it into understandable English. It is done in this way:

When you are told that an oil has a density of "so many degrees Baumé" just add the "so many degrees Baumé" to 135.88 and divide the sum into 145.88. The quotient is the density. Isn't that easy enough?

For example: What is the density of a "31-deg. Baumé" oil?

$$31 + 135.88 = 166.88$$
$$145.88 \div 166.88 = 0.875$$

In other words, the oil is just 7/8 as heavy as water.

It is evident, then, that an oil the density of which is 10 deg. Baumé is just as heavy as water because—

$$\frac{145.88}{10 + 135.88} = 1$$

The density of an oil can be determined with accuracy, however, without the use of a hydrometer. If you have an accurate weighing instrument you can do a more accurate job.

In a nutshell, this is the method:

(a) weigh a clean, empty jug.
(b) weigh again when filled with water.
(c) weigh again when filled with the oil.

The density can then be determined by using this simple formula:

$$\text{Density} = \frac{c - a}{b - a}$$

This, you will note, is nothing more or less than dividing the weight of a certain volume of the oil by the weight of the same volume of water. If you have accurate and delicate weighing balances, I would suggest that you use a small vial for this test. If you have nothing but large scales for weighing heavy objects, you can do the test very well by using a large or ordinary jug as suggested above. The temperature of the water, oil and jug should all be the same while doing the test. If possible, the temperature of all three should be 60 deg., as that is the standard.

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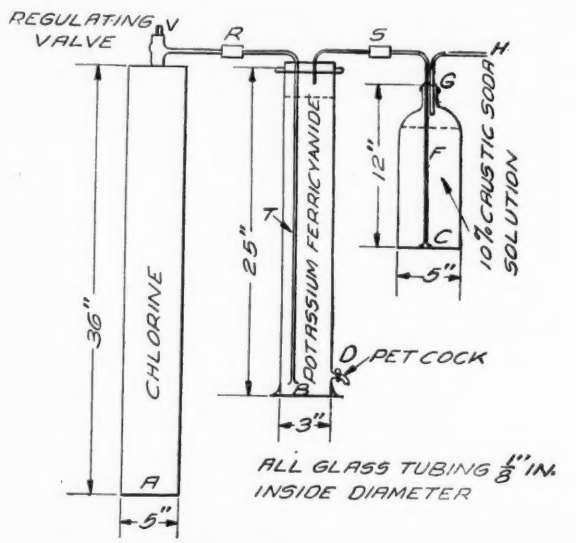
Coating for Blueprint Paper

An Inexpensive Method of Preparing Potassium-ferri-cyanide

BEFORE the beginning of the war, potassium-ferri-cyanide was obtained for 55 cents a pound, and now sells for $5, and since blueprint papers are coated almost exclusively with potassium-ferri-cyanide, an inexpensive method of producing it is of vital interest.

Apparatus has been devised by the U. S. Bureau of Chemistry to produce, by the oxidation of a solution of potassium-ferro-cyanide and chlorine gas, potassium-ferri-cyanide solution, at prevailing prices of the materials, for approximately $2.80 a pound. The chief precaution to be taken is that the finished solution does not contain an excess of chlorine.



APPARATUS FOR THE PREPARATION OF POTASSIUM-FERRI-CYANIDE

Allowing for possible loss, 100 lb. of potassium-ferro-cyanide should yield about 75 lb. of potassium-ferri-cyanide. Probably 10 lb. of chlorine would also be required. That is, 1⅓ lb. of potassium-ferro-cyanide oxidized with approximately ⅛ lb. of chlorine, would yield 1 lb. of potassium-ferri-cyanide.

The apparatus and method for making potassium-ferri-cyanide are described as follows:

This apparatus is designed to produce 1 lb. of potassium-ferri-cyanide from 1.33 lb. of potassium-ferro-cyanide. Cylinder A, containing chlorine, is connected through regulating valve V, by tubing and rubber connector R to B, a glass cylinder for solution of potassium-

ferro-cyanide. C is an acid bottle containing a solution of sodium hydroxide for absorbing excess chlorine. Cylinder *B* has a glass pet cock, D, near the base, and is fitted with a 3-in. cork, sealed with paraffin and carrying tubes T and E, T extending to the bottom of the cylinder and flared to distribute the gas. Tube E, which does not touch the surface of the solution in B, is connected by a rubber tube, S, to tube F, running to the bottom of the acid bottle, C, which has a cork, G, sealed with paraffin and carrying E and H, which is so connected as to carry off unabsorbed chlorine. All tubing should be of glass ⅛ in. inside diameter.

Dissolve 1.33 lb. of potassium-ferro-cyanide in about 2.5 qt. of distilled water and pour into cylinder B. Nearly fill bottle C with a 10 per cent solution of sodium hydroxide or caustic soda. Turn on chlorine gas from cylinder A by valve V and allow it to bubble slowly through the solution in B. Shut off the chlorine at intervals of ½ hr. or so, and aid the absorption of the gas by shaking container B. Prevent caustic soda solution from sucking back from C when gas is shut off, by slipping off connection S between B and C immediately after shutting off the chlorine. Continue passing chlorine into the potassium-ferro-cyanide solution for some time after the color has darkened considerably; then make frequent tests to determine when oxidation is completed, by drawing off through pet cock D, a little solution from B; dilute with distilled water and add a solution of ferric chloride. If a blue precipitate is formed, the process must be continued, but if a brownish solution results, the oxidation is complete. When oxidation is complete, turn off chlorine gas and connect T with an air pressure line. Bubble air through the solution until no odor of chlorine is noticeable. If no air pressure is available and suction can be obtained, break the connection, S, connect E with the suction and draw air through the solution until free of chlorine.

Great care must be exercised that no chlorine escapes into the room, as serious injury to the throat, nose, eyes and hands may result from exposure to the fumes or contact with the liquid. The operations must be performed under red or orange light, and the solution should be made up only as needed for use in coating paper.

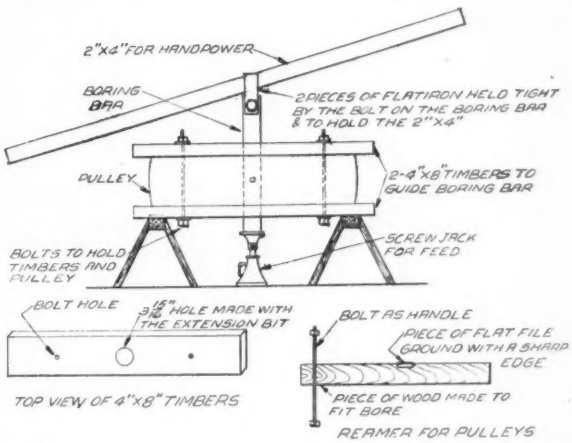
Erecting Odds

MISSING PARTS, LACK OF STANDARDIZATION, CARELESS SHIPPING METHODS ARE MOST FREQUENT CAUSES OF ERECTING TROUBLES. BY CHAS. LABBE

THE erecting engineer is compelled to take his work in different places with varied conditions and may have to resort to many schemes to make ends meet, which is, no doubt, why many of them have gray hairs long before their time. New mills in mining districts are seldom erected near a city and likely far from any foundry or machine shop where the engineer must have recourse to his limited number of tools to apply to the many cases of misfits that are sent him.

When all (?) the material called for in the specifications and plans has arrived on the ground, and everything fits in place and can be turned over in good condition on the date specified, well and good; but this is seldom the case, as I know from an experience I had in Nevada, 30 miles from the railroad. Teams were bringing in the material, shafting was coming from the East and pulleys from the West, and I can believe that if these articles of machinery are standardized the 2 standards are widely apart. The parts maybe were sent as shown in the shipping bill, but were not received in quite that way, and from what happened it would appear that shipping in lots means lots of parts missing. To come to our subject, most of the trouble was with the pulleys and shafting coming from different places. The main shaft was 3 15/16 in. and none of the 11 pulleys belonging to it would go on the shaft, all from 5 to 10 thousandths of an inch too small. Filing pulleys with a hub 12 in. long did not appeal to anyone, nor to file 80 ft. of shafting, either, so we rigged up a device to make a cut in the pulleys. We took a piece of 4 by 4 about 3 ft. long, the hardest we could find, and with the draw knife made it round to 3 15/16; in the center was inserted a piece of flat file, about one inch long, with an edge ground like a reamer. On one end of the timber a ¾-in. hole was bored and through this a ¾-in. bolt was driven to use as a handle; it worked nicely and saved time.

The crusher pulley, 14 by 60 in., was bored to 4 7/16 to go on a 4 9/16 shaft. This was more puzzling, for with


2"x4" FOR HAND POWER
BORING BAR
2 PIECES OF FLAT IRON HELD TIGHT BY THE BOLT ON THE BORING BAR & TO HOLD THE 2"x4"
PULLEY
2-4"x8" TIMBERS TO GUIDE BORING BAR
SCREW JACK FOR FEED
BOLTS TO HOLD TIMBERS AND PULLEY
BOLT HOLE
15/16" HOLE MADE WITH THE EXTENSION BIT
BOLT AS HANDLE
PIECE OF FLAT FILE GROUND WITH A SHARP EDGE
TOP VIEW OF 4"x8" TIMBERS
PIECE OF WOOD MADE TO FIT BORE
REAMER FOR PULLEYS

TOOLS MADE FOR THE EMERGENCY

a chisel and file it would be difficult to keep the bore true; even our wooden reamer was of no use and to ship it back and have it rebored meant too much delay, so we made a vertical lathe as follows: We placed the pulley on 2 carpenters' horses; a piece of 3 15/16 shafting, 4 ft. long, was quickly transformed into a boring bar by drilling 3 holes in it, 2 at the middle, 1 for the cutter and 1 tapped for a ½-in. set screw. The cutter was made of a piece of square file with the end ground and held in place by the set screw. Two pieces of 4 by 8 timber were bored with the extension bit with two 3 15/16-in. holes to act as bearings for the boring bar, the timbers were bolted on each side of the pulley and centered with the rim, the lower end of the boring bar rested on a screw jack so that a regular feed was no trouble. On the top of the bar a bolt and 2 pieces of ½ by 1½ flat iron held a 2 by 4, long enough that 2 men could walk around. This finished the lathe and furnished the power; the boring was done in 2 cuts, the finish and trueness were equal to any "factory made."

Manufacturers of pulleys may depend on set screws; but personally I do not, especially if 2 set screws are to hold pulleys 4 ft. in diameter on a 3 15/16 shaft, and numerous were the keyways we had to cut in pulleys. We made quick jobs of them, first traced them and with the hacksaw cut both sides, leaving a part easily chiseled out and with little to file.

Twenty-four 1¼-in. foundation bolts came in one bundle and in a sack 24 nuts supposed to fit the bolts, but the nuts were "standard" and the bolts at least 1/32 oversize. We had no taps or dies of that size and something had to be done to cut the threads down. First we filed the tops of the threads with a flat file and with a 3-wheel pipe cutter we sunk the threads deeper. It made the threads a little V-shaped, but with a 2-ft. wrench we gave the nuts the best fit.

Among the missing parts (and they only are missing when you are ready to put them together) was a rod for a Cornish pump 30 in. long, 1½ in. diameter, with 4 in. of thread both ends. The water was needed and we had to get the pump in action so we devised the following scheme: We were lucky to find the 4 1½-in. nuts, so we polished a piece of 1½-in. rough iron and then proceeded to cut the threads. We traced the threads on both ends of the rod on 4 sides, then on 8 sides with a fine center punch. With a new 3-cornered file we made about half the depth, helping with the 3-wheeled pipe cutter; as soon as the nut started the finish was easy, 2½ hr. being the time it took to thread both ends.

In starting up, I told one of the natives to throw the clutch, always progressively, to give time to the machinery to attain a good speed before locking the clutch; but my words proved to be unheeded, as he threw in a clutch so brutally that a flange coupling split in 2 pieces at the keyway, shearing 2 of the 5 bolts. This happened just the morning of the "great day," a couple of hours before the swell dressed directors were to give their O. K. and hand out freely small cigars with big labels. The coupling was off the shaft and in the blacksmith shop in a jiffy; a ring of 2 by ½-in. flat iron was made, welded and shrunk on the hub and a ring of the same iron made and shrunk on the outside of the flange; the coupling was back on the shaft before the bands were very cold, the whole plant was soon running as if nothing had happened.

Manufacturers vary widely in the way they pack shipments of machinery; some take great care and understand the rough travel their machinery will have to stand and, wishing the user to receive it in the best order, pack and box accordingly, while some just deliver on the railroad freight platform just the way it came off the machine tools. When shipping a crankshaft with both flywheels, why not use blocks of wood to hold the crankshaft firmly. In unloading men are apt to be careless with their crowbar and allow a flywheel to drop several inches. The crank shaft may be made of steel; but so are buggy springs, with the difference that the former is not made of steel which will stand many jumps and bumps; a sprung shaft is not very pleasant and I am not surprised that some bearings run hot.

All bearing journals should be bound up with small planks bound together, because in nearly all cases the indifferent help does not pay much respect to bearing parts; they are for him the handiest places to place a bar or chain, for were not the 2 sides made so carefully true in the lathe meant to provide a safe rest for his crow bar? Such smooth parts are inviting to pound on; if there are any scratches or bumps, he should worry, the engineer will "file that off."

I remember of a bullwheel 72 by 18 in. made of wood finished all over, varnished, very well made, shipped from the East to the extreme West, arrived at its destination with crowbar marks and scratches nearly an inch deep, in such shape that it took a full day for a carpenter to repair it. In the first place, to box or crate it may have cost a dollar and this would have been a good saving both in the repair bill and the cost of the firm's reputation.

Shipping machinery without some protection is not safe, as an example will show. A hoist of a well known maker shipped in good running order was left nearly a week on the freight platform. When the buyer took the hoist to the place of erection he was much surprised to see all the oilers, the sparker, one valve and spring and the *piston rings* missing. I suppose some one having an engine of like make helped himself to those parts which he needed for repairs.

Bearing parts should not only be boxed but painted or greased with some hard grease; in transit, machinery is often left out in the weather and rain or snow attacks polished surfaces quicker than any others.

Completion of the Quebec Bridge

DURING the third week in September, the last span of the Quebec bridge was put into place. When open, this bridge will carry the traffic of eight railroads across the St. Lawrence River and will reduce the rail distance between Halifax and western Canada 200 mi. On Sept. 17, the central span, which is 640 ft. long, and the keystone of the structure, was floated down to the bridge site on scows and fastened in place. When the scows were removed, the 5000-ton mass was raised in 2-ft. stages and that night swung 28 ft. above the position from which it was started upward. It was raised 42 ft. the next day, and reached its final position on Sept. 20.

Profiting by the disaster of last year, the engineers used all possible precautions against a recurrence. The care with which the calculations have been made can be realized from the fact that the 5000-ton mass of metal varied only ⅝ in. from the computations as to how far it would bring down the cantilevers after the scows had floated from beneath it. After each hoist, the mooring trusses, which ultimately will hold the span in place, were attached in order to hold it still until the jacks were made ready for a new upward thrust. The span was raised in 2-ft. stages, instead of the 3-ft. stages used the year before, and on Sept. 19, when the span had reached the middle of its 150-ft. ascent, the speed of hoisting was reduced from 2 ft. in 11 min. to 2 ft. in 14 min. In 1907 a structure of nearly the same magnitude collapsed, causing the loss of 70 lives.

THE RAILROAD connecting Chile and Bolivia, which crosses the Andes 14,105 ft. above sea level, provides oxygen chambers in which passengers can get relief from the rarefied air of the high altitudes.—Compressed Air Magazine.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Waiting for Speed to Catch Up

I HAVE READ with considerable interest the article on page 783 of the Oct. 1 issue bearing the above caption.

I have in my hydro-steam-electric installation, a governor of the type described. Originally this governor "waited for the speed to catch up," but it preyed on the nerves of my assistant so much that I cut out about 15 parts of the relay and now it doesn't wait so long as formerly and my assistant is more contented.

If my reasoning is correct, the relay on any apparatus is simply to operate the main valve or gearing and a compensating device of some nature must be in the construction of said relay in order that the main valve or unit may operate in proportion to the pilot valve.

I believe the Spencer damper regulator illustrates this feature with the fewest possible parts of almost any steam appliance.

It is just as impossible to regulate a water wheel if the governor has to wait the pleasure of the water as it would be to regulate a steam engine and await the pleasure of the fireman. A proper head of water must be maintained to meet the greatest demand on the water wheel or the wheel must slow down (or up, if you choose), regardless of size, style or build of governor. But, if the above named condition—namely lead—is fulfilled, the speed should remain constant, or practically so.

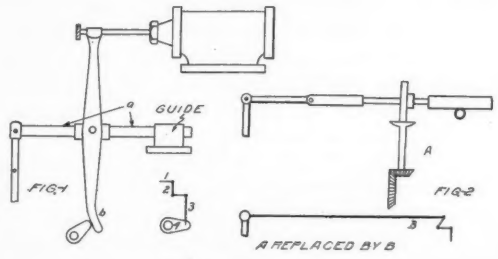


FIG. 1. CHANGES IN COMPENSATING GEAR AS MADE BY TOM THUMB

FIG. 2. PINION, RACK, FRICTION WHEEL, BEVEL GEARS, ETC. WERE ALSO ELIMINATED

Then again, if the load goes off suddenly, where would you fit if the governor was slow in closing, just to accommodate the inertia of the water? A vent pipe is provided in a tight flume or penstock to take this sudden 'kick'—which acts like a hydraulic ram. If Chief Wallace were fussy, methinks he would not wait for the speed to catch up, but would liven his governor just a trifle.

In the governor mentioned, we changed the compensating gear as shown in Fig. 1.

On stem (a) we eliminated several parts, making this all one piece without screw on end or pinion gear, and all the compensating is done with (b) as fulcrum.

The cam at (b) is made so that as the load increases the valve is centered more slowly, allowing the speed to increase rather than decrease. We also eliminated pinion rack, friction wheel, bevel gears, brass screw socket guide, etc., as indicated in Fig. 2.

My assistant one day asked permission to show a friend the plant. I, of course, granted the request. It happened that the friend was more or less posted on the water wheel governor in question and remarked the absence of the bevel gears used in driving the compensating device.

This is what I heard my assistant tell him:

"The chief is more than fussy at noises and anything that bothers him so he can't sleep has to move. Well, those pesky little bevel gears got on his nerves so one day that he couldn't get his after dinner nap; darned if he didn't pull 'em out and the darned thing seems to run better and act quicker without 'em."

Please don't misunderstand my letter and think that I am an unbeliever in inertia, but I will not allow my wheels to await the pleasure of the water, inertia or not,

TOM THUMB.

Stopping Leaks

ON PAGE 785 of Oct. 1, 1917, issue of Power Plant Engineering, I find an article by W. F. Schaphorst on "plugging the leaks." It is a very good article, in my opinion, in the main; yet reference is made to something which, with all my 28 yr. experience, is new to me. "Shaft slip"—this is something I don't understand. Of course, I've had wooden pulleys to slip on the shaft, yet they made so much noise that for my own peace of mind I would "fix" them, even if I had to take barrel staves and whittle out a set of shims large enough to grip when the hub bolts were set up. I have had metal pulleys slip when held only by a set screw, but always made a point to set up the screws till they held. If no other way could be had I'd countersink in the shaft and put a lock nut on the set screw to hold her in after she was tight. If pulley bore was too large I'd shim. Generally, pulleys are secured with keys and often with both keys and set screws. So where any slip could take place is beyond me; and presuming that there was some slip, I don't see why nor what an engineer gets paid for except to stop such things. If a man expects the boss or the owner to "plug" all these leaks, what on earth does he, the engineer, expect to get paid for? His good looks? I'm afraid, being so homely that the dogs run from me,

I'd never get salary enough to subsist on, for I'm a heavy eater.

There is no doubt that one could go into the finest, best maintained plant in the world and find places where "plugs" would help, yet I'll venture to say that in these better maintained plants you will find men in charge who personally go far beyond their ordinary duties of shoveling coal and drawing their salary to see that all these leaks are plugged and are forever hunting others to remedy. I know that in the plant under my care are numerous holes which require plugging—and I can honestly say that I'm calling but little on the boss to furnish plugs; I'm either finding old material which has become too worn for its original purpose and using it for "plugs" in other places, or I'm inventing some new way to fix up the holes—and they are being "fixed" every day. Of course, new ones come, or old "plugs" wear out; yet back I go and oftentimes, though I work a regular shift of only 6 hr., I am at my place of business 24 hr. working over these same leaks. I make a point of staying with a thing until it is repaired, even though it is but an unimportant factor or though it required 48 hr. or even more, to fix it—I stay with it personally until it is done. I don't believe any engineer worthy of the name *has* to run his bearings until they won't run longer—nor do I believe any engineer worthy of being so called has to use the cheapest grade of anything, for by his works shall he be known and once he shows any owner—and naturally the owner is a business man or he wouldn't be owner—that he is competent to use the better materials, then he can demand and get them, because the better material is money saved for the owner.

A salary increase is the hardest thing for any man to get and this I find is governed a great deal by wages paid in neighboring industries. An owner, however, having once seen that his engineer is a capable man worth more to him than some other one might be, will generally pay more to keep him rather than take chances on a new one.

A short time ago, I wrote the Editor for a series of articles and discussions to be called for from his readers regarding how best the salaries of engineers could be, in general, raised. A courteous reply came, but owing to certain existing circumstances the Editor felt that the time was not yet ripe for such a series. Therefore, feeling that I was worth more, and believing that the owner knew it, I simply went to him and, like a gentleman, told him I'd like to have more, and why. I didn't threaten to quit, go on a strike or anything like that, I took a copy of my plant and plant service record with me—and a copy of my home accounts which I carefully keep. I first showed him that directly through myself I had made him big money in more ways than one. I then showed him that I was running behind in my current expenses, owing to living having gone higher than salaries. I explained that I felt that I should have a living and at least 10 per cent left over of my salary to lay up for the coming old age. We figured it out and —I got it. I later heard him say that it was much better to pay more to a man who worked in *his* interest to "plug the leaks" than to hire a man who either *wouldn't* "plug" them or who didn't *know how*. If I had a pulley which carried 100 per cent shaft slip, I'd buy a pocket knife and get a splinter from a dry goods box and shim her up if nothing better were in sight.

JOHN PIERCE.

More Engine Trouble

A CASE SIMILAR to that mentioned by H. A. Jahnke in Oct. 1 issue, once called the writer. The latch steel or catch plate on the hook had become broken square across the bolt hole, but the countersunk head of the bolt kept it from falling off. Still it was loose enough to lean over, each stroke preventing the release of valve.

In another instance, the governor had a tendency to race, causing the engine to run very irregularly. The governor was completely overhauled, but nothing could be found which would indicate the cause. One of the steam valve stems was very loose from wear in the steam bracket. This trouble was remedied, and the governor gave no more trouble. This was just another case of the hook not releasing the steam valve properly on account of play of valve stem in the bracket. TOM JONES.

Powdered Coal

THE PRACTICE of using powdered coal is as yet in its infancy and there are many points on this subject which need to be more fully described, and probably will be in due time as this system of combustion becomes more widely used. In the article on this subject appearing on page 771 of the Oct. 1 issue, mention is made of a number of items on which a more detailed explanation would be of interest to many engineers. The article in question mentions one or two plants as an illustration, and in which this system shows excellent results. It would be of interest to have a more detailed description of how the coal is dried—and the length of time required to put the coal through the drier.

It seems to me that inasmuch as drying is highly essential there is a considerable amount of heat radiated from the tops of the boilers which in many plants have a temperature sufficiently high to evaporate considerable moisture from the fine coal, especially if the air is handled by a fan. If the drying is to be accomplished by the use of steam coils, the steam used would mean a considerable item in the cost of operation. In plants having induced or forced draft, it ought to be possible to utilize a great amount of the heat in the waste gases after they leave the boiler or economizer for drying the powdered coal, without affecting the operation of the boiler. This would require a special arrangement of heating surface, but will probably be worked out as this system becomes more fully developed.

In speaking of a power plant the article in question states that "drying, pulverization and handling is accomplished in the usual manner." More details on the usual practice would be of interest. The waste culm or "slush" used in making the tests shows an average of 24 per cent ash. This means that nearly ¼ of the fuel remains in the furnace and setting. What becomes of this ash? A considerable part of it will lodge on the tubes; in fact, the article states that horizontal baffles were not successful due to the fact that the ash collected on them. Would it not be necessary to use a soot blower several times a day? In burning a powdered coal having from 20 to 24 per cent ash, it seems to me that serious trouble would be had from the ash filling up the back chamber of the B. & W. type of boiler and the middle chamber of the Stirling, and that a very hard clinker would be formed in the furnace, and also on the tubes above the furnace, from the sulphur and iron and other components which form the clinker.

A coal having 24 per cent ash and a heat value as low as 11,500 B.t.u. would be a difficult fuel to use even with the best of stokers, and an evaporation of 8.1 to 9.8 lb. of water per pound with a percentage of 16 per cent CO_2 is considerably better than could be expected in any case except where the plant was prepared especially for making a test run.

One of the greatest difficulties in stoker and hand firing is to get the proper proportion of air to maintain as nearly as possible complete combustion. In blowing powdered coal into the furnace it seems to me that the proper ratio of air to coal could be maintained to get the best results similar to the theory of the gasoline carbureter or in oil and gas fired boilers. Possibly these things have been discussed and have escaped my attention, but I believe that there is yet much experimenting to be done before the powdered coal system of combustion is brought up to the same high standard as our present stoker-fired systems. More discussion on this system and its details would be interesting to every engineer confronted with the present fuel prices.

J. C. HAWKINS.

Two Eccentrics on Corliss Engines

IN THE ISSUE of Oct. 1 J. C. Hawkins says that my statement concerning the object sought in adding a second eccentric to a Corliss engine seems to contradict itself. If he understood perfectly the operation of such an engine my statement would appear reasonable.

For several years previous to his death, I was acquainted with an engineer who was probably the first, or at least one of the first, to add a second eccentric to a Corliss engine. He informed me that it was done for the purpose of saving steam. The result was that it saved $600 worth of steam the first year it was used. In no case has it ever added power to such an engine.

Let us review the action of a single eccentric engine, and see why the foregoing statement is true. The engine is started and a light load put on. More load is added until the maximum point of automatic cutoff is reached, which is ½ stroke. When a little more load is put on, what happens? The engine takes steam full stroke, and when this is done the addition of another eccentric cannot increase the mean effective pressure. Then why is it put on?

For 5 yr. I operated a Corliss engine, and under certain conditions it took steam full stroke. It was a simple, noncondensing engine and when cutting off at 1/5 stroke it would develop one horsepower hour for each 3 lb. of coal burned in the furnace. When a change of conditions caused it to take steam full stroke, it was very wasteful of steam. Why was this true? Because there was no point of automatic cutoff between ½ stroke and full stroke. The addition of another eccentric would have given a cutoff at ⅝ or even ¾ stroke and this is evidently more economical than taking steam full stroke.

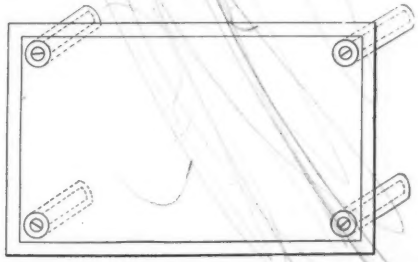
Of course if the cutoff took place at ¾ stroke the mean effective pressure would be lower than for full stroke; but the former is frequently enough for the given load, hence the saving of steam.

J. C. Hawkins says, "adding another eccentric is done for the purpose of securing a later cutoff and higher mean effective pressure, which in turn increases the available power of the engine, making it possible to add more load." The trouble with this logic is that it assumes that when the limit of automatic cutoff is secured, no more steam can be admitted to the cylinder. This is true of some kinds of engines; but it does not apply to the Corliss, hence his philosophy is all wrong. With steam going into the cylinder full stroke, a certain mean effective pressure is secured. If the cutoff takes place at ¾ stroke the mean effective pressure is slightly reduced. This feature is well illustrated by the diagrams which he presents on page 787 of the above-mentioned issue.

W. H. WAKEMAN.

Preserving Accessibility of Name Plates

PRACTICALLY every large piece of power equipment is now fitted with a name plate bearing the name of the maker of the apparatus, the address of the company, patent dates, type and size of the machine, serial number for identifying it, the maker's records, date of sale, and other information of interest and value as a matter of reference and record. Often, however, it is advisable and good economy to cover equipment, such as heaters, hot water controls, separators, etc., with asbestos lagging in order to conserve the heat which would otherwise be radiated and lost, and in these cases the identification or name plate is often covered and obscured.



HEATER NAME PLATE KEPT IN VIEW BY MOUNTING IT IN THIS MANNER

We recently covered our heater with a magnesia plaster, and preserved the name plate in the manner shown on attached sketch. The lagging was about 2 in. thick and we therefore cut 4 pieces of small ¼-in. pipe 2 in. long and secured 4 long screws. The short screws holding the name plate to the side of the heater were then removed, the plate lifted out and then the four 2-in. long pieces of pipe were placed behind each screw hole, the long screws serving to hold the plate in position about 2 in. from the heater body. When the magnesia covering was finished, the name plate was on the same level as the outer surface of the coating and made a neat and attractive job, while preserving all the data and information recorded on the name plate.

M. A. SALLER.

Handholes in Centrifugal Pump Suction

QUOTING FROM the letter of E. C. Wells in the issue of Oct. 15:

"There is no reason why these handholes could not be made when the pump was built, which would certainly have been a great improvement, for it is beyond the writer's imagination to understand how a builder

or designer could ever expect the nozzles to be cleaned if once they become clogged."

The pump maker in this case has been unduly criticised, as in the manufacture of pumps and other machinery the maker must take certain things for granted and design and manufacture as near fool-proof as possible, supposing, of course, that the machine will have proper installation, which was not the case in the pump under discussion.

If Mr. Wells knows the construction of the single-stage centrifugal water pump as made today, he was taking all kinds of chances in drawing from an unguarded or open end suction pipe, thereby permitting the entrance "of blocks of wood and rubbish" which are bound not only to clog the runner, but oftentimes ruin it by having a solid jamb between the end of impeller blade and throat of shell.

Here is a case where the ounce of prevention would have been worth more than the pound of cure, as a strainer on the end suction pipe would have kept foreign matter from the pump.

Pumps are seldom made with handholes unless so ordered or the pump is used for raising solids where an unobstructed opening in the suction line is desirable. If the working conditions of the pump were known to Mr. Wells and he was instrumental in its purchase, he made a serious mistake; a dredging pump should have been chosen, as this, without question, would have given much better satisfaction with an open suction.

J. D. McRae.

Getting a Raise

In looking over the issue of Sept. 15, I find answers to "The Chief's" query as to getting salary raise.

Perhaps it may interest the readers to follow the careers of two young engineers during a period of 10 yr. These two young men started firing in a large plant at practically the same time; but owing to an accident, one of the young men was in a hospital for several weeks, and when he was able again to resume the shovel the position he had formerly occupied was no longer open.

He was informed that he could have a job as oiler at another of the company's plants at less money; but his friend counseled against such a move, as he should be fighting for more money instead of less.

The young man came to me and asked me what I would do, and I answered:

"Take the oiling job, by all means, Ed.

"It will pay you less money; but beggars can't be choosers, and perhaps you will learn enough to make up for the loss in coin."

He took the job as oiler, while the other fellow still stayed in the boiler room at more money.

It may seem strange, but they both obtained engineers' licenses at practically the same date, and both were offered the same job a short while after.

The job was offered to the former fireman first, but he refused, as the money paid was too little, but the oiler accepted, as he thought it was an advancement.

The fireman stayed firing because the money paid was more, even though he held an engineer's certificate; but the other fellow shifted, as did "A. A. W."

In 8 yr. from the time they both entered the boiler room, the one had changed jobs nine times, while the other had held down the same job and, I am forced to admit, accumulated many more shekels than the other. But the man of experience was getting ready to do something, apparently, for a couple of years ago these same two young men applied for the same position, and the man of the varied experience landed the job, which has proved to be a good investment for both his employer and himself. The other young man is also in charge of a plant, but his salary is just a trifle over half of the other fellow's.

Now, what has all this got to do with a raise in salary? The man who gets the experience will sooner or later get the paying job. If you are worth more money than you are getting and can't get it where you are, go somewhere else. If you are qualified to take a bigger job, take it when it shows up; and if it is slow in showing up, go after it.

The writer has worked as chief at present hydro-steam-electric plant for 14 yr., and has had salary doubled voluntarily. The 7 yr. preceding, the writer worked as assistant and chief in seven plants. I always raise my worthy help the limit voluntarily and just as promptly discharge the unworthy. T. Thumb.

I want to thank those who offered suggestions as to securing a raise in salary, also for their criticism of indicator diagrams. I'll now tell you how I didn't get the raise. I advertised for a chief engineer's position and was offered charge of a power station at a substantial increase. My present employer decided to give me as much as I could get elsewhere. Having a day off duty, I took part of it looking over the new job. I found the chief running his own shift alone, having sent his oiler into the boiler room to replace a fireman who had gone out on a little celebration and had become "filled with the spirit." He seemed to be pretty busy running four large compound engines and looking after his switchboard. It didn't take me long to make up my mind that my little old job was good enough for me at the same wages. In due time payday came, but I didn't find any more money in my envelope; another payday, and it was just the same. (I am now doing some more advertising.)

In regard to the indicator diagrams, the engine referred to is belted to the same jack shaft as our water wheel, the engine acting as a governor for the water power.

I want to tell a little experience with the indicator. Having a high-speed engine to indicate, I sent my indicator to a prominent maker of engineers' instruments to put on a detent motion and cord take-up device. It came back with the frame of the instrument sprung and detent motion looking as if it had been designed by the office boy and stenographer; otherwise, in pretty good shape. I found by testing it that the parallel motion would not draw a line at right angles to the atmospheric line. I took off the drum and put the end of the frame in a vise and sprung it back into correct position. After putting it together, I found I had got it just right; at least, it will draw a line exactly vertical now. Moral: Don't send your instruments to anybody for repairs except to the firm that made them.

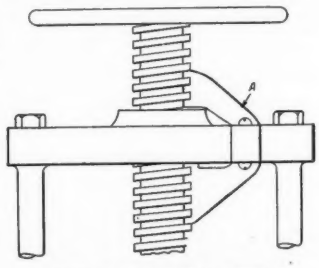
The C[illegible]

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Keeping Valve Stem Threads Free

MANY TIMES I have gone up over the top of the boilers to open or close one of the valves, and found that a 14-in. monkey wrench was required to be applied to the valve wheel for additional leverage to move the stems. A great deal of dust and ash or coal dirt finds its way up there, and settles in the valve stem threads; more especially does it stick there if the stems are oiled. If the stem threads are not cleaned out before operating it, some of the dirt is carried into the threads of the yoke, and after a while it packs in so tight that the stem works very stiffly.



THREAD CLEANING DEVICE

To prevent this trouble, I made a sort of scraper out of an old packing ring spring, annealing and flattening it, then bending it to fit in the position shown, filing teeth to fit the thread pitch, and secure it to the yoke with a couple of ¼-in. machine screws. I have fitted a number of the large valves with these thread cleaners, and they well repay the odd time spent in making them.

C. H. WILLEY.

Unusual Method of Refitting Re-babbited Box

THE THRUST BEARING of a turbine waterwheel became overheated and the babbit melted out. To take out the lower half of the box it was necessary to remove the stud bolts holding this to its pedestal, the bolts holding the clutch lever and those holding the pedestal to lower the frame and to slide the pedestal out from under the box.

After filling the oil ringways with clay, the upper half of the box was blocked up under the shaft, babbited and then properly fitted.

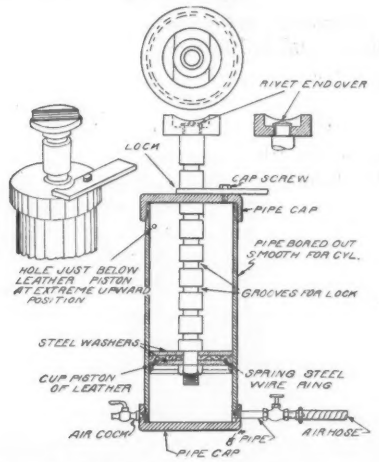
Oil ringways and oil well of lower half of box were nearly filled with waste with a covering of clay added. The box was then placed under the shaft, the pedestal slipped in place, the box cemented and everything assembled as before taking down, with the exception of the clutch lever bolts between the two pedestals. The box was then babbited.

Not having the necessary time to take down and fit, [illegible]ste were removed and washed out. The top half was put in place, the necessary shims fitted and then again removed. Clutch lever bolts between pedestals were replaced and lever adjusted to take care of the clutch properly. The wheel was started and water turned into box. Lava soap was then held against the shaft and the thrust rings which gave these parts and the bearing a fine polish. After about an hour's treatment the box was washed free from soap, the oil chamber filled with oil and the upper half replaced and properly adjusted. It then ran without further trouble.

C. A. EVERETT.

A Readily Made Air Jack

SHOWN IN THE accompanying illustration is a simple quick-acting air jack which readily may be made, for the greater part, from pipe and pipe fittings. The jack may be locked in various positions by means of the locking dog placed on top of the cylinder fitting in any one of the grooves provided for the purpose in the piston rod. The seat on top of the piston rod should be made loose so as to form a swivel joint.



DETAILS AND SECTIONAL VIEW OF AIR JACK

To operate the jack, place the air release valve in the closed position and open the air valve when after the jack has reached the proper height lock it by means of the locking dog. To lower, disengage the locking dog and open the air release valve.

C. C. SPREEN.

BECAUSE men do not undertsand, do not have the full knowledge of things, they become prejudiced, and prejudice is one of man's greatest enemies. To be prejudiced means to pre-judge, which destroys the sense of justice, prevents him from dealing fairly with others, and therefore with himself. It robs him of all powers to distinguish right from wrong.—Koehring Mixer.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

A Massachusetts Examination

FOLLOWING is a list of examination questions recently asked applicants for first class engineer's license in the state of Massachusetts. The questions, together with the answers given, were submitted by Receiver.

Assume having a hot well 12 to 15 ft. below the engine room floor. How would you obtain the temperature of the water in this well?

A. Place a thermometer in the discharge pipe of the air pump.

2. What other method could you employ?

A. Place a thermometer in a thermometer well provided for the purpose in a small pipe connecting the hot well with the suction of the air pump.

3. The area of a boiler stay is 1.68 sq. in., the allowable strain per square inch of area is 6500 lb. and the area supported by each stay is 80 sq. in. According to this, how great a pressure would you allow the boiler to carry?

A. Multiply the sectional area of the stay by the allowable strain and divide the product thus obtained by the area supported by the stay. Or, 1.68 times 6500, divided by 80 is equal to 136.5 lb.

4. Under what conditions will scale form over a bridge wall.

A. When the fire in a furnace is banked, the lowest setting temperature will be found in the fire box. At this time the circulation of the water will tend to reverse and the sediment will deposit on thin surfaces of the shell which are the coolest, which in this case are those directly above the furnace and the bridge wall.

Some claim that the great deposit of sediment at this point is due to the greatest evaporation taking place here when the boiler is working.

5. How may the horsepower of an engine be increased?

A. By increasing the mean effective pressure, by speeding up the engine, by installing a condenser or, if necessary, by using a larger cylinder.

6. How are receivers protected from over pressure?

A. By means of safety valves provided for the purpose.

7. How would you determine the pressure at which to set this valve?

A. Calculate the safe working pressures for both the receiver and the low-pressure cylinder and set the valve to open at the lower pressure thus obtained.

One way is to assume that each is built to carry a pressure which would allow equalizing the load between the two cylinders. We can then figure equal expansion in each cylinder in the following way: We will assume that the initial gage pressure is 120 lb., and that a vacuum of 25 in. is being maintained. The absolute initial pressure is then equal to 120 plus 15, or 135 lb. A 25-in. vacuum is practically equal to 25 divided by 2, or 12.5. Fifteen minus 12.5 is equal to 2.5 lb. as the absolute back pressure in the low-pressure cylinder.

The total number of expansions is equal to 135 divided by 2.5, or 54, or in each cylinder is equal to the square root of 54, or about 7. Now the high-pressure terminal and receiver pressures are the same so that 135 divided by 7 or 19 lb. is the allowable pressure.

8. How would you proceed to set the valves of a compound engine provided with independent steam and exhaust valve eccentrics?

A. Set the high-pressure valves first, and with the eccentrics on that side in position, do the best you can with the low-pressure side.

9. A steam header supplies superheated steam to an engine and a turbine through individual branch leads. The superheat of the steam interferes with the proper operation of the engine. What might be done to avoid this trouble?

A. If lubrication was interfered with and the oil did not give satisfactory service, it would be advisable to try another oil having a higher heat test.

If, however, this did not help matters, you might then as a last resort try to reduce the temperature of the steam going to the engine by uncovering the branch lead connecting with this unit. And while the radiation losses would be increased thereby, the temperature of the steam would be brought near that corresponding to saturated steam of like pressure.

10. How would you shut down a turbine?

A. Trip the automatic safety stop.

Boiler and Pump Questions

WHAT IS the maximum thickness of boiler plate used on stationary boilers? Why are they not 1 in. thick?

2. Why are the valves of a duplex pump given lost motion?

3. Which of the two water leg plates of a Manning boiler is the thicker?

4. What other than low water and scale will cause the tubes at heads of horizontal fire-tube boilers to leak repeatedly after being rolled? F. J. G.

ANSWERS

IN GENERAL, stationary boilers have a shell thickness ranging from ¼ to ½ in., although boiler plates have been made in special instances with a thickness of 1½ in. When the thickness of the plate exceeds ½ in., the heat transmitting properties of the plate are reduced and boiler efficiency is lessened. Ordinarily a plate ½ in. or less in thickness provides sufficient strength to carry

standard pressures and a 1-in. thickness would not only increase the cost of the boiler, but make it less efficient.

2. Lost motion on the valve of a duplex pump allows the valve to remain motionless part of the stroke, thereby permitting the piston to make the full stroke before the valve is reversed.

3. In the Manning boiler, the inner furnace sheet is invariably made thinner than the outer furnace sheet, owing to the fact that it is under compression. The outer furnace sheet is made thinner than it would be if it were not a staybolted cylinder, but the staybolts tend to prevent it from rupturing as it is being held by the staybolts, which, of course, are in tension, tending to collapse the inner shell.

4. Leakage of the tubes of a return tubular boiler may be caused by excessive expansion and contraction as a result of sudden variations in temperature. Firing up the boiler too rapidly may bring that about. Leaky tubes are apt to be encountered if cold feed water is permitted to enter and be impinged on hot tubes.

W. P.

Calculating Charge for Heating Service

THE QUESTION as to the best method of figuring the proper charge for heating service in a residence, where such heat is furnished by a central heating plant, has come to my attention, and I would like some of your good advice and information, also any suggestions that you can offer. Two methods are under consideration:

1. Measurements taken from the outside of the building multiplied by the height from the first floorline to the ceiling of the second floor. The cubical contents, as thus figured for the space actually heated, figured at 4/9 c. per cu. ft. gives the price.

2. The use of this formula:

$$\frac{\text{Cubical contents}}{85} + \frac{\text{net exposed wall area} \times 7.5}{85} + \frac{\text{Exposed window and door area} \times 75}{85} = \text{required radiation at 25 c. per sq. ft.}$$

In either case, the season would be Sept. 15 to June 1. Pipes must be covered in basement. Storm windows must be used.

Water shall enter the building at not less than 130 deg. F. when outside temperature is at 32 deg. F. and shall be raised 1 deg. for each drop of 1 deg. F. outside; heat of 70 deg. F. in the coldest weather guaranteed.

The first method has been used and makes the cost about the same as use of anthracite, figured at $8 or $8.25 a ton. Second method is suggested, and on the face of the formula would greatly increase the cost.

Are these methods, either or both, sanctioned or approved by engineers of recognized authority or experience? Is there any better method or methods? If so, what? Have you any criticism to offer of the second method? M. H.

A. The rate of 4/9 c. per cu. ft. of space heated corresponds very closely to the average of 19 central heating plants, tabulated by the National District Heating Association, which works out to 0.409 c. per cu. ft.

The second formula is a variation from a formula frequently used for getting the radiating surface required. In its usual form this is: Add together the cubical contents, 10 times the exposed wall area, and 100 times the exposed window and door area, and divide by 70. On account of using storm windows, your rule has been made to give a somewhat smaller radiation surface than the above; but I should judge, for this climate, you would probably be all right. The rate of 25 c. per sq. ft. of radiation is rather higher than the average charged. For an average on 19 central hot-water heating plants, the rate per square foot of radiation was about 20 c.

The temperature for your water in the building is practically right, and should give satisfactory results.

I think the second method proposed is the more logical, as the first one takes no account whatever of the amount of glass surface or exposed wall surface, and this has a good deal of bearing on the radiation required to heat a building properly. Both methods have the sanction of practice, but the first one is more a rule of thumb and is liable to go wrong in case of any unusual exposure or construction of the building walls.

A. L. R.

Location of Fuse Plugs; Salinometer Readings

WILL YOU kindly inform me as to the proper location of a fusible plug in a Scotch marine boiler?

2. What reading of the salinometer should indicate an excessive volume of salt in water?

3. How is the salinometer graduated? J. O. O.

ANSWERS

LOCATIONS of fusible plugs in Scotch boilers are as follows: Marine type, in combustion chamber; in dry back type, in rear head, not less than 2 in. above the upper row of tubes.

2. It was formerly the practice not to let the saturation of the water in the boilers exceed 2/32. This limit to saturation has, however, been raised to 5/32, as less scale-forming matter is carried into the boiler at that density than at the lower one. The reason that less scale-forming material is carried into the boiler when the water is at a high density is that less water requires to be blown off and replaced. Besides this, there is the additional advantage in a high saturation of less waste of heat.

3. A salinometer is graduated by trial, placing it first in fresh water having the temperature at, say, 200 deg. F. The depth to which the instrument sinks in water is marked on the glass tube. It is then placed in water having the same temperature and containing 1/32 part of salt. The depth to which the instrument now sinks is the sea-water mark, and it is also marked on the tube. This operation is repeated with water containing 2/32, 3/32, and so on up to 12/32 part of salt, always taking care that the temperature of the water is exactly 200 deg. F. The marks on the tube are transferred to a paper scale, which is pasted to the inside of the tube in exactly the same position as the marks on the tube. The distances between the marks are usually divided into halves, quarters and eighths. If the salinometer is to give a correct reading at 190 deg. F. or 210 deg. F., the process of graduating must, of course, be carried out at the desired temperature throughout. Knowing the process of graduation, a salinometer can be

improvised out of a piece of thin tubing, a tall and slender bottle, etc.

If the hydrometer is placed in a vessel containing some water drawn from the boiler and having a temperature equal to that at which the instrument was graduated, it will sink to a depth corresponding to the density of the water, and the saturation may be read off on the scale. For instance, if the hydrometer sinks to the 2⅞ graduation on the scale, it means that here is 2⅞ lb. of solid matter in every 32 lb. of water.

Should the temperature of the water under test vary from the temperature at which the hydrometer was graduated, the indication of the hydrometer will not be correct. This is due to the difference in density of water at different temperatures. Allowance may be made for this error in the following manner. The indication of the hydrometer will vary 1/80 part of 1 lb. of solid matter for every degree the temperature of the water varies from the temperature at which the hydrometer scale was marked.

Thus, if the temperature is 205 deg. F., a hydrometer graduated at 200 deg. F. will show 5/80 part of 1 lb. of solid matter less than there really is in the water. For instance, the temperature of the water being 205 deg. F., and the hydrometer indicating 1 15/16 lb. of salt, the actual amount of salt will be 5/80 of 1 lb. more, and as 5/80 = 1/16, 1 15/16 + 1/16 = 2 lb. will be the actual saturation. Also, if the temperature of the water is less, the indication of the hydrometer will be too high. For example, the temperature of the water being 180 deg. F., and the hydrometer indicating 2¼ lb., the indication will be 20/80 lb. too high. Subtracting 20/80 = ¼ from 2¼, 2 lb. is found to be the true amount of solid matter in every 32 lb. of the water drawn from the boiler.

O. H. H.

Casehardening Machine Steel

HAVING EXPERIENCED considerable difficulty in obtaining satisfactory results in our endeavor to caseharden machine steel, I am prompted to make inquiry of you as to the best method, or process, by which this quality of steel can be successfully treated.

F. GEBHARDT.

A. Carbonizing, or casehardening, is a form of heat treatment designed to produce a hard wearing surface on a tough interior. The process is applicable to wrought iron, mild steel and certain of the alloy steels, and is in principle the same as the cementation process for the manufacture of crucible cast steel. The articles to be treated are placed in a cast-steel box and packed around with carbonizing mixture. The cover is then sealed on, and the box raised to a bright cherry red heat, say, 955 deg. C. (1750 deg. F.), preferably in a gas-fired oven or furnace in which a reducing atmosphere is maintained, the temperature being regulated by means of a pyrometer. The temperature is kept up for some time, depending on the depth of "case" required, and the carbonizing medium used. The box and its contents are allowed to cool down before opening, and after cleaning, the articles are ready for the second operation of re-heating and quenching. The surface to the depth of 1/16 in. or more has been converted into high-carbon steel, which is hardened by this latter treatment. The core in the interior is required to remain tough and fibrous, and it is desirable to bring out fully the fine-grained structure by a second heating to the proper temperature, say, 871 deg. C. (1600 deg. F.), followed by quenching in cold water.

Messrs. Vickers, Ltd., of Sheffield, state that a much better result is obtained by first heating to 899 deg. C. (1650 deg. F.) and quenching in cold water, then re-heating to 788 deg. C. (1450 deg. F.) and again quenching in cold water. This gives a fine white glass-hard skin, with a very tough and fibrous backing.

The casehardening mixture consists of certain substances rich in carbon, usually of organic origin, and containing also nitrogenous matter. The presence of nitrogen appears to be essential, carbon alone being very feeble in its action. Bone dust, horn, hoof and hide clippings, scraps of leather and similar substances are specially prepared by calcination and charring, and sometimes mixed with a quantity of vegetable oil. Certain chemicals, such as barium carbonate and yellow prussiate of potash, are also occasionally added, and this latter substance alone, when powdered and sprinkled upon a surface of wrought iron or mild steel which has been raised to a cherry red heat, is capable of producing a very thin casing.

To produce a casehardened article having a hard skin with an interior core of tough ductile character capable of resisting fracture under shock, it is not essential, as commonly assumed, to use very soft steel of low tensile strength. Casehardening nickel steel is now produced, giving an exceedingly hard skin with an interior core of high tensile strength, but, at the same time, an entire absence of brittleness. Messrs. Vickers, Ltd., who are well known as makers of this and other types of special steel, state that to obtain a thickness of skin of 1/32 in., suitable for gear wheels, etc., the articles should be heated to 1750 deg. F. in any commonly used casing mixture. At the end of 2 or 3 hr. the box containing the articles should be allowed to cool slowly. When cold, they should be removed and heated in a gas muffle furnace for hardening. With casehardening nickel steel, two entirely different results may be obtained by hardening in cold or in boiling water. Quenching in the latter gives a rather softer skin, and a much softer core. For hardening in cold water, the temperature should be raised to 760 deg. C. (1400 deg. F.), the steel removed from the furnace, allowed to cool a few degrees in the air, and then quenched. To harden in boiling water, the article is heated to 1450 deg. F., and at once plunged into actually boiling water. The results obtained are shown in the following table:

TENSILE TESTS OF VICKERS' CASEHARDENING NICKEL STEEL

CONDITION	Elastic Limit Tons per sq. in.	Ultimate Strength Tons per sq. in.	Elongation Per cent on 2 in.	Reduction of Area Per Cent
Softened for machining...	28.0	33.0	33.0	65.0
Quenched in boiling water from 1450 deg. F.....	30.0	36.5	32.0	70.0
Quenched in cold water from 1450 deg. F.....	61.6	67.6	16.0	57.0

The special alloy steels so much used in motor car construction, where it is desired to bring out great strength and toughness, together with fatigue and shock-resisting properties, are subjected to a form of heat treatment which must be carried out with great care and extreme accuracy. For instance, chrome-vanadium

steel for crankshafts is first heated to 849 deg. C. (1560 deg. F.) for ¾ hr., and is quenched in oil. It then undergoes a process of annealing for about 8 hr. in a bath of molten lead, and is finally allowed to cool down in lime. W. P.

How May He Eliminate the Rattle?

FOLLOWING are some of the suggestions and remedies offered by readers of Power Plant Engineering relative to the engine valve trouble of G. R., published on page 748 of the Sept. 15 issue.

The rattling referred to is probably caused by varying and unequal pressures on the two sides of the exhaust valves. The valves may first be lifted from their seats by the pressure in the exhaust pipe increasing above that in the cylinder and then dropped when the pressure on the two sides is equalized by the opening of the port.

No doubt the light load results in a very short cutoff, allowing the steam to expand below that in the exhaust line; the only remedy for this is a reduction of boiler pressure.

Rattling may also be caused by the valves moving endwise in their chambers, although this would be accompanied by more of a knock than a rattle.

End motion may be eliminated by removing the back bonnets from the valve chambers and placing a sheet metal shim between the end of the valve and the bonnet.

C. B. HUDSON.

THE GENERAL CAUSE of this trouble is too early cutoff. The steam expanding below atmospheric pressure, the exhaust valves are lifted from their seats by the unequal pressure. When the steam valve opens, the steam rushes in and sends the valve down onto the seat again, producing a rattle; the greater the boiler pressure, the greater will be the noise.

G. R. states that this occurs when the steam pressure rises. If such is the case, the easiest and quickest way to stop the rattle is to reduce the boiler pressure to a point which will bring the terminal pressure to about 16 or 17 lb. absolute; as this is above the atmospheric pressure in the exhaust pipe, the valves will remain on their seats.

A cross compound condensing engine will rattle the same on very light loads on the low-pressure side, especially if there is a vacuum in the receiver. The remedy in such a case is to shorten the cutoff on the low-pressure side enough to raise the receiver pressure to zero or above. But with a single cylinder noncondensing engine there are not so many changes possible. The most common is to reduce the boiler pressure and keep it down to that point until such time as sufficient load may be added to the engine. If the engine is too large for the load, it would be better to put a smaller cylinder on the engine or have the old one bushed to receive a smaller piston. If this is done, the bush must be most carefully fitted, or it may work loose, or, if the bushing is fitted too tightly expansion may cause a crack or fracture of the cylinder, so that in the end a new and smaller cylinder may be the cheaper.

Shoulders worn on the seats of the valves will also cause a clicking sound, the noise increasing as the boiler pressure increases. Broken snap packing rings or rings not fitting the grooves in the piston will also cause a clicking and rattling noise in the cylinder which may appear to be in the valves. R. A. CULTRA.

THIS TROUBLE is probably caused by the steam cutting off so early in the stroke that it expands below the atmospheric pressure and forms a partial vacuum in the cylinder which raises the valves from their seats. Then when the valves open, they drop back again, causing a rattling and snapping sound.

I will give a description of a method I used to overcome a bad case of valve rattle:

The engine was an 18 by 36-in. Nagle Corliss, single eccentric, running 85 r.p.m. on 90 lb. of steam and doing duty in a lighting plant.

With a medium or heavy load this engine ran fine, but with an exceptionally light load such as was carried from midnight until morning, the valves were very noisy.

I noticed, with steam at about 50 lb. and the load light, that the valves ran more quietly, but it was impossible to operate at this pressure on account of having to operate a steam pump on full boiler pressure.

One night, as the load became light and the valves started to rattle, I opened both valves on the indicator pipe and let steam blow through the pipe from one end of the cylinder to the other. The valve quieted down at once. Enough steam from the high-pressure side of piston flowed through the pipe to the exhaust side and prevented a vacuum from forming and causing an unbalanced condition of the valves. This was, of course, a waste of steam; but it produced the desired results for the time being.

I would suggest that G. R. make adjustments so that release and compression take place later, if he has a single eccentric engine. Retarding the eccentric will make all events taken place later, and he may have to give the steam valves less lap by shortening the radial rods and making the valve open sooner. H. B.

Can You Suggest a Remedy?

WE HAVE a 12-hp., 3-cycle, vertical gas engine, which has been in service for about 10 yr. During all this time it has received good attention, but for the past year we have had complaint of it requiring more frequent replenishing of the oil supply in the crank case, the oil working up past the pistons. We also installed a 2-cycle vertical, 20-hp. only a year ago, and 1 or 2 hr. operation so much oil will work up past the pistons that it will ooze out around the igniters and drown out the igniters until they fail to operate.

We have tried lowering the height of the oil in the crank case in these engines to almost the danger point and have put new rings on the pistons, but with no improvement.

On a recent visit to another city I stepped into a plant where there was a 4-cycle vertical engine, which was being dismantled to clean the oil off the pistons and cylinders and I was told this was a common occurrence, although this engine has been in service little more than a year.

Can any of the readers give us a remedy for this trouble? West Va. Traction & Electric Co.

C. E. N.

THE TEMPERATURE of a boiler tube is within 20 to 35 deg. F. of that of the boiler water, and the temperature of the tube is affected very little by the temperature of the hot gases, but follows the temperature of the water in the boiler.—A. S. M. E. Journal.

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Saving Coal and the Bonus System

Nearly all of our present industries depend to a great extent upon coal to keep them going. Without an adequate supply, the production of equipment for war must halt; transportation facilities will be greatly reduced, not only on steam railroads but street car service will be greatly reduced, thus interfering with city traffic; the homes throughout the country will suffer with cold. Today, with railroads and manufacturing establishments carrying on business to an extent never experienced before and at the same time a scarcity of labor in coal mines, the saving of coal is a duty every man who uses coal owes to the government, the industries of the country and the homes of his fellow men.

It was stated recently by Van H. Manning, director of the Bureau of Mines that if consumers could be aroused to an intelligent consideration of the burning of coal they could begin to save ten per cent of the production (600,000,000 tons) at once. With more effort, through instruction and a moderate remodeling of coal burning equipment, which could all be accomplished during the war, a further considerable saving can be made.

It would obviously be impractical to scrap all out-of-date power plant equipment. We must start by doing the best we can with what we have. Saving coal at once is a necessity, for the present output of the mines, although somewhat better than last year at this time, is not sufficiently greater to meet the demands of increased business. This problem is personal. It deals with the human element. The man with the shovel must appreciate the situation and work to effect a substantial saving.

About fifteen million people shovel the 20 per cent of our coal used for domestic purposes. Only two hundred and fifty thousand firemen shovel the sixty-odd per cent of our coal used by power plants and railroads. While each householder should recognize his duty, greatest efforts must be made in the coal using industries.

The average householder is interested in saving coal for financial reasons and should realize that when he throws a shovelful of anthracite coal in his furnace its value is equivalent to half a pound of sugar, or half a loaf of bread, or a pint of milk. The possibilities of savings in homes are considerable, for few homes are properly provided with weatherstrips, double windows, pipe coverings, damper regulators, tight fittings in ash pits, furnace doors and dampers, and too little attention is given to keeping tubes and flues free from scale and soot. Much saving of fuel can be effected by thought and care in firing house furnaces and too little attention is given to the humidity of the atmosphere in homes, for comfortable temperature with proper humidity is several degrees below what will be comfortable when the air is of low humidity.

To the firemen in power plants and on railroads, however, we must look for the greatest saving. Entirely too many manufacturers make a mistake in failing to consider the fireman as a skilled workman. Too often he is treated as a mere coal passer. His instructions are frequently little more than to keep steam pressure up and water level within reasonable limits. Without careful training and proper instruments for observing

furnace conditions, the fireman's efficiency must be low. The encouraging feature in the present situation is the existing condition just mentioned, for we believe employers, in their earnest efforts to reduce coal costs, will turn their attentions to the much neglected firemen who are as a rule doing their best but without the proper co-operation from authorities high up. It is no longer cheaper to pay for coal than to secure good firing.

As one solution to the problem of fuel saving, we are firm believers in the bonus system, for no man will put his best thought and energy into his work without proper incentive. With young men that incentive may be, and usually is, the desire for experience and intimate knowledge of his duties; with older and experienced men the financial side usually appeals most strongly, and here is where the bonus system serves best. Care, however, must be taken to plan a system that will affect individuals responsible for the result rather than a group, in other words, one which is fair and equitable.

Such a system, we believe to be that suggested by Jos. W. Hays, in which he holds the fireman responsible for the combustion efficiency of his furnace. When the boilers and furnaces are in proper condition the efficiency of the men in charge of the furnaces is a close measure of the efficiency with which the steam is generated. Since the percentage of CO_2 in the flue gases measures quite accurately the efficiency of combustion, the necessary information for applying the system is readily obtainable. To encourage the firemen, however, all reasonable aid should be given them in the way of instruments and instructions by which they can better their record.

"Gas and Flame" Engineers

EXPERT MECHANICS AND CHEMICAL WORKERS ARE WANTED TO SERVE WHERE SKILL AND EXPERIENCE ARE NEEDED. THE "GAS AND FLAME" SERVICE OF ARMY ENGINEERS NEEDS YOU NOW

POWER Plant Engineering has been called upon by the Commanding Officer of the 30th Engineers to help in mobilizing the personnel of a "Gas and Flame" Service Regiment. This regiment is being recruited now from men volunteering for the service, and will be ready to go "over there" by Thanksgiving. It is a regiment for skilled, practical men, who will be called upon at once to demonstrate their worth and skill.

Major Atkisson, of the 30th Engineers, authorizes the following statement:

Enlistment in the "Gas and Flame" Regiment offers opportunity to skilled men, to be used and recognized as men skilled in their trade, and should appeal to men who have previously felt that they were most needed at home, because of their special training and experience.

The regiment will be required in the field of operation to supervise the American offensive in "Gas and Flame" service and will be called upon to instruct men all along the front in this most important work. Consequently these men, all volunteers, will be in the thick of the greatest activities.

The 30th is the pioneer regiment in the "Gas and Flame" service, hence men who enlist now will be leaders in the spring offensive.

WHO CAN QUALIFY

CHEMISTS (analytical, research and manufacturing), chemical workers, powdermen, men experienced in gas manufacture, machinists, automobile repair men, men able to operate and repair gas or steam engines, pipe fitters, electricians, designers, interpreters, carpenters, blacksmiths, plumbers, boiler-makers and chauffeurs. Men with long experience in their trade are especially desired to fill the Master Engineer grades.

All men enlisted in the Thirtieth must have good muscular development and be capable of undergoing active service at the front. Men are wanted who know how to take care of themselves, who are active, energetic, and have a strong determination to carry out any mission to which they may be detailed.

Loyal American citizens with the above qualifications between 18 and 40 yr. of age, who have not actually been called by a local board in the draft, are eligible.

OFFICERS AND SPECIALISTS

COLONEL A. A. FRIES, Engineers, N. A., is to be the Commanding Officer of the 30th Engineers. He is a regular officer of the Corps of Engineers with many years' experience in military and civil engineering. Colonel Fries is now in France and is "Chief of the Gas Service."

Major E. J. Atkisson, Corps of Engineers, is organizing the first battalion of the 30th Engineers at Camp American University, D. C. He is a graduate of West Point and of Cornell University. Major Atkisson has specialized in Electrical and Mechanical Engineering. His assignments have included: Director of Electrical and Mechanical Engineering, Engineer School, U. S. Army, and Superintendent, Gatun Locks, Panama Canal.

HOW TO ENLIST

GO TO the nearest recruiting station or U. S. District Engineering Office, state fully and clearly your qualifications and that you wish to be enlisted in the 30th Regiment of Engineers (Gas and Flame). The officer in charge will examine you physically and pass upon your qualifications. If accepted, you will be enlisted and immediately sent to Headquarters of the 30th Regiment of Engineers at Camp American University, D. C.

All men must first enlist as privates, the rate of pay being $33 a month and expenses. Men with the necessary experience may be assigned to special duties and given non-commissioned rank at rates of pay ranging from $40.20 to $96 a month and expenses. The latter include, for both privates and non-commissioned officers, food, clothing, medical attendance and transportation. Those who enlist will be eligible immediately for promotion, according to their ability and as openings occur. Men who enlist now will have excellent opportunities for promotion as the service expands.

EVERYBODY CAN HELP

IF NOT qualified for enlistment, get at least one man to volunteer. You can be an immense help in this way even if you yourself are not in a position to serve.

2. Get this announcement printed in your local newspapers. *This is exceedingly important.*

3. Manufacturers, see that a few men of your organization respond to this call.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Unusual Experience with Pipe*

ORDINARY pipe is used in various industries and some peculiar experiences are encountered. We mention below some unusual or "freak" incidents in which the inherent qualities of "punishability" of pipe are demonstrated—for the most part by unusual accidents. As will be noted, it would be practically

FIG. 1. TELESCOPED PIPE FROM OIL WELL

impossible to duplicate the circumstances involved in connection with many of the various pieces shown.

A string of 340 ft. of 10-in., 32,515-lb., South Penn. oil well casing fell 236 ft. when an elevator let go. Figure 1 shows what happened to the bottom length

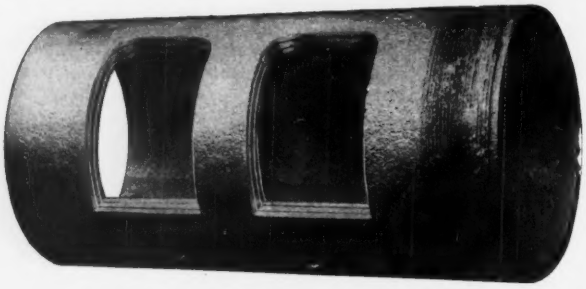


FIG. 2. THREE-IN-ONE SECTION CASING

when the casing hit the bottom of the well. The thread protector was forced over the threads and up over the pipe approximately 12 or 13 in., and the pipe was bent backward and inward. As will be noted, however, the material shows no fracture. This happened in the Oklahoma field.

Figure 2 shows "3 in 1" section of casing. There was a string 1440 ft. long, of 8¼-in., 24-lb. steel casing; the elevator let go and the string, weighing somewhere over 34,000 lb., dropped 200 ft. to a bottom of limestone. The three sections on the bottom were telescoped—one inside and one outside. It will be noted, there was no failure in the weld, the three lengths telescoped without a crack. The exterior apparently shows a straight length of casing. The particular piece shown was machined to show the three separate sections as telescoped.

Note the circumstances are substantially the same as Fig. 1, but the results radically different. This happened in the Ohio field.

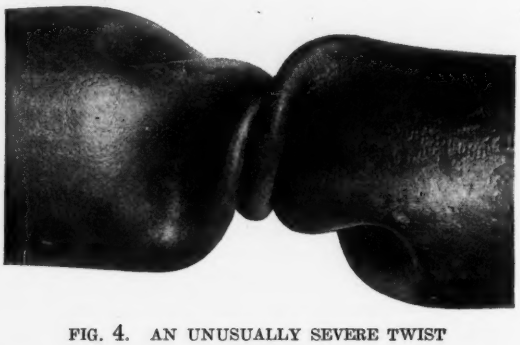


FIG. 4. AN UNUSUALLY SEVERE TWIST

In Fig. 3 are 26 lengths of 4-in. rotary pipe, about 500 ft. in length. The well was about 2000 ft. deep and all the pipe was out of the ground excepting this particular 26 lengths when the gas began to show up and blew the pipe completely out of the well, without making a sign of a break in a single joint of the 26 lengths. One of the operators well said that this pipe was "flexible as a giant whiplash." This happened in the Texas field.

Figure 4 shows a piece of 8-in. line pipe subjected to a twisting strain of 713,000 in.-lb. In appearance this is almost like a piece of rubber, and yet when it is remembered that this pipe has a thickness of about ⅓ in. and weighs about 29 lb. per ft., the enormous twist-

*Information supplied from files of Research Department of National Tube Co.

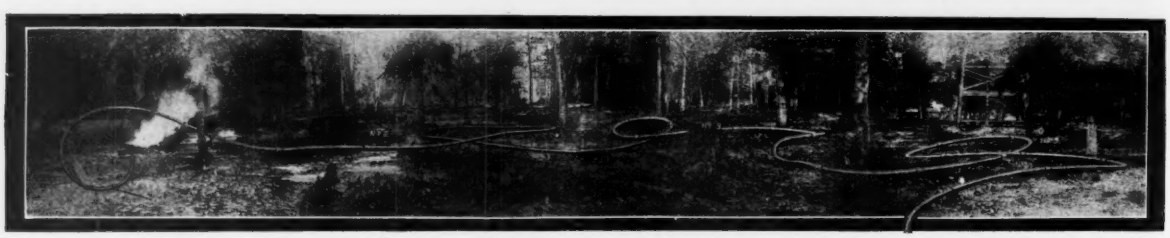


FIG. 3. A GIANT WHIPLASH

ing strain can be appreciated. No sign of fracture appears in the material.

Figure 5 illustrates a number of pieces of pipe welded together by the autogenous welding process and then bent into the shape shown. The white or frosted effect is due to the fact that this was connected up with a refrigerating machine and all the pipe is covered with a thick frost.

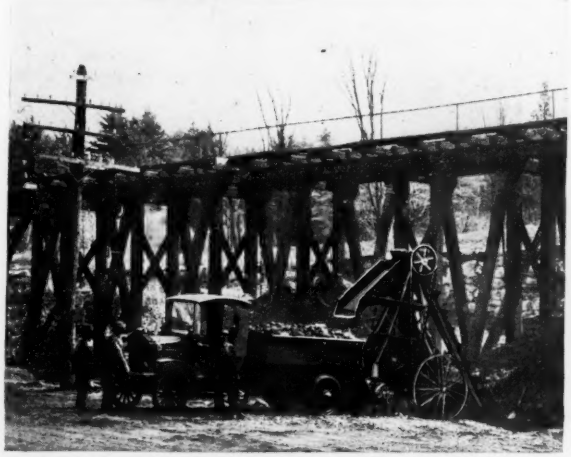
FIG. 5. PIPE WHICH HAS BEEN WELDED AND BENT

Figure 6 shows a bow-knot made from pipe and is self explanatory. These unusual pieces of pipe tend to show the inherent reserve strength of tubular material.

A few years ago, it would have been impossible to secure pipe with physical properties such as shown, and these specific examples reflect the advance and improvement in metallurgical methods and practice in the manufacture of steel for pipe.

Use of a Truck Loader

BEING CONFRONTED with the problem of loading coal from their ground storage pile by other means than hand shovelers, the American Optical Co., of Southbridge, Mass., found a solution by purchasing a Link-Belt wagon and truck loader. This machine loads



WAGON AND TRUCK LOADER USED BY AMERICAN OPTICAL CO., SOUTHBRIDGE, MASS.

the material at the rate of one ton per minute and requires but one man for operating thereby cutting down the operating costs. Their situation was peculiar in that the coal storage pile was some distance from their power house, and thus required transportation and transferring of coal before it reached the boilers. The truck is kept on the "go" constantly, as it requires only a few minutes to load it.

The bituminous coal arrives by the carload and is dumped from the trestle to the ground storage pile. It is then loaded into trucks by the loader for transportation to the power house, where it is again transferred and fed to the automatic boiler stokers.

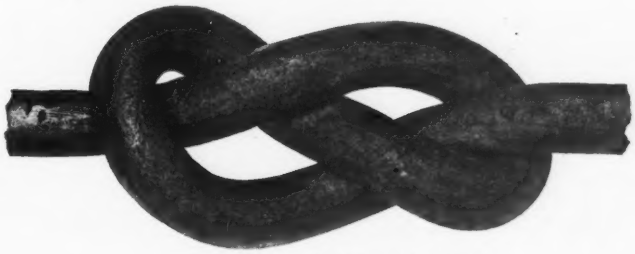
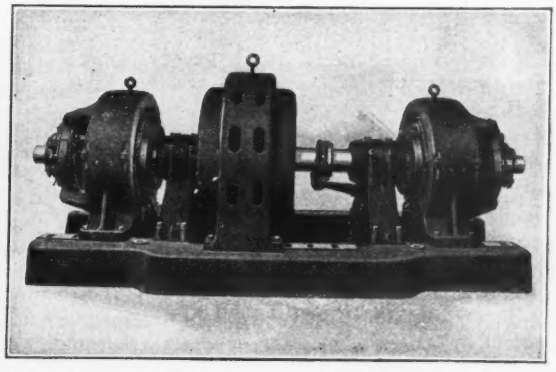


FIG. 6. A BOW-KNOT OF PIPE

The automatic loader illustrated is operated by an electric motor and loads the truck shown beside it in about 5 min. With the use of this machine they have reduced the cost of handling their coal as well as gravel, over 50 per cent, and the same machine is also used in their sand bank, with very good results. It enables them to handle in one day as much as was formerly handled in two days. Not long ago the loader loaded 80 cu. yd. of earth which was carried one-half mile round trip by a two-ton truck in one day.

Two-Bearing, Three-Unit Motor-Generator Sets

TWO rubber manufacturing companies in Ohio have each recently installed two three-wire, direct-current motor-generator sets that in construction are a departure from the usual practice. Instead of being of the old four-bearing, three-unit type or the two-unit type with a three-wire generator as one of the units,



FIVE HUNDRED-KW., 720-R.P.M., THREE-UNIT SYNCHRONOUS MOTOR-GENERATOR SET

these sets consist of three units with only two bearings.

These sets, which were designed and built by the Crocker-Wheeler Co., consist of an 845-kv.a. 2200-volt, 50-cycle, 3-phase synchronous motor driving two 250-kw. 125-volt compound-wound interpole generators.

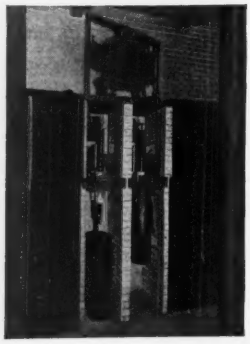
The use of three units results in greater unbalance overload capacity and greater flexibility of the direct-current voltage than is obtainable with a two-unit set having a three-wire generator as one of the units.

As compared with the old four-bearing, three-unit construction, these two-bearing units are much simpler in construction and have the following advantages: The absence of outboard bearings makes the brushes more accessible for adjustment and the unit can be assembled, dismounted and cleaned more readily. Perfect bearing alinement can also be secured with greater ease as self-alining bearings are used. The machines can, hence, be erected with less labor. Because of the shorter length of the set, less floor space is required. Couplings which in some cases constitute a weak link are eliminated.

New Westinghouse Oil Circuit Breakers

TYPES E-6 and E-7 oil circuit breakers are part of a complete line recently developed by the Westinghouse Electric & Mfg. Co. as a modification of Types E-2 and E-4 breakers, which were the first breakers of medium rupturing capacity to be furnished for wall or pipe mounting without the need of a cell structure.

Types E-6 and E-7 breakers range in capacities from 300 to 1200 amp. at 23,000 v., and from 1600 to 2000 amp. at 16,500 v. Type E-6 is for cell mounting, and Type E-7 for wall or pipe mounting. Operation may be manual, by bell cranks, or electric by solenoids, control in both cases being from the switchboard. All steel construction is used, thus providing breakers exceptionally compact for their rupturing capacity, which ranges from 35,000 to 40,000 kv.a. at maximum rated voltage with proportionately higher capacities for lower voltages.



WESTINGHOUSE TYPE E-6 OIL CIRCUIT BREAKER

These breakers are of the unit-pole type, made up by combining single poles mechanically connected for control by single hand lever or electric solenoid, which permits spacing according to local conditions. For cell mounting, one of the new and especially valuable features is a convenient arrangement by which the steel base of each pole unit is held in channel irons built into the cell walls. These units are, therefore, easily slid in and out of these channels, and when in service, are tightly clamped in place by set screws. Another new feature in the standard arrangement of electric operating solenoids for cell mounting breakers, is the mounting of the single pole solenoid complete with its mechanism on a plate and channel frame fastened to the top of the cell structure. In the pipe or wall mounting form of breakers, the pole units are mounted on horizontal pipe supports. Manually operated breakers are full automatic in operation, and the electrically operated breakers can be made full automatic by special arrangement.

To break the arc as quickly as possible after the breaker starts to open, these breakers are provided with accelerating springs. An adjustable air cylinder dashpot is furnished to take up the shock of the moving parts at the full open position. The contacts open by gravity, assisted by the accelerating spring referred to. The moving contacts are of the laminated brush type amply protected from arcing by butt type arcing contacts of increased size. One of the features of special importance introduced into all of the breakers is the ability to clear the system of a short circuit up to its rated capacity 3 times without attention to contacts, which will still be in such condition that the breaker may be closed and operated after the third short circuit.

The tanks are elliptical in form, of double lap welded sheet steel, conveniently arranged for mounting and dismounting.

Auto Truck Runs Pipe Threader

THAT "necessity is the mother of invention" is amply proven by the accompanying illustration.

C. Risager, a wide-awake, progressive plumber of Aberdeen, S. Dak., received the contract for a large plumbing and heating job several miles out in the country. The work had to be done in a hurry.

Mr. Risager, not caring to go to the expense of moving a heavy stationary power machine (weighing a ton or so), secured a shaft having a universal joint at each end. One end of this shaft he fitted to the

DRIVING A BEAVER DIE STOCK WITH AN AUTO TRUCK

rear axle of his Ford truck, and the other end to the driving pinion of a No. 41 "Beaver" easy working die stock, threading pipe from 2½ to 4 in.

Mr. Risager states that this ingenious arrangement has proven absolutely satisfactory, and in the future he will never worry about threading a large amount of 4-in. pipe out on the job.

The home-made arrangement did the work!

WE ALL want to go to heaven—but there is no demand for rapid transit.—Colorado S. of M. Magazine.

News Notes

THE CHICAGO OFFICE of the Ashton Valve Co. will hereafter be located at 318 W. Washington St., Chicago.

CHARLES C. CHEYNEY, manager of the Chicago office and store of the Buffalo Forge Co., has a commission in the Naval Aeronautic Corps and is beach engineer at Pensacola, Fla., in charge of aeroplane engines.

GRIGGS & MYERS, consulting engineers, New York City, have under their charge the design and installation of a 12,000-kw. power station for the Wright Wire Co. of Worcester and Palmer, Mass. The plant is to be used in connection with the present works at Palmer and for large future developments.

C. F. GOODRICH, assistant manager of the Buffalo Forge Co.'s Boston office, has left for active duty as First Lieutenant in the Ordnance Department, and is stationed at the Watervliet Arsenal.

Don R. Marsh, production manager with the same company, has given up his work to assume similar duties at Washington in the production of ammunition. Mr. Marsh will receive a Captain's commission.

Catalog Notes

FROM THE BIGELOW CO., New Haven, Conn., is received an attractive and interesting book giving the features of the Bigelow-Hornsby water-tube boiler. This describes in detail the construction features, dealing with the size of units, the circulation, economy, heating surface, baffling and smoke flue connection, superheating, accessibility, furnace construction, the features of strength, safety and portability, and shows by large, clear illustrations the details of a number of important installations.

A valuable feature of the book is a table of the properties of saturated steam, and the properties of superheated steam, adapted from Marks & Davis tables. The book is substantially bound in heavy cloth covers, and will be found an addition to the working library of the power plant engineer.

SPRACO PRODUCTS including spray cooling, air washing and cooling, and paint spraying equipment, park sprinklers, flow meters, and nozzles for all purposes, are illustrated in Bulletin No. 501, which gives a condensed summarization of the principal Spraco developments of which Spray Engineering Co., 93 Federal St., Boston, Mass., is the manufacturer.

Spraco pneumatic painting equipment is described in the company's Bulletin No. 311.

WIRE IN ELECTRICAL CONSTRUCTION, a cloth-bound book published by John A. Roebling's Sons Co., Trenton, N. J., contains useful information as follows: Weights and measures, conversion tables, areas of circles, wire gages, copper, aluminum, steel and bronze wire, properties of metals, electric transmission of power, galvanized strand, river crossing wire, trolley wire, insulated wires, insulations, different styles of cables.

BULLETIN NO. 46,028, describing the Temperature Indicator, is being distributed by the General Electric Co. The Temperature Indicator equipment, as explained, affords a convenient and rapid means of indicating continuously, at the switchboard, the temperature of various portions of the windings of electrical machinery under operating conditions. Temperature Indicators are furnished mounted on small marble or slate panels on wall supports measuring 31 by 16 by 1½ in.

NONPAREIL INSULATING BRICK for boiler settings is the subject of a circular from Armstrong Cork & Insulation Co., Pittsburgh, Pa.

THE PROVIDENCE FITTINGS CO., Auburn, R. I., has lately issued a folder giving description and prices of the Excel union.

NEW PUBLICATIONS of Link-Belt Co., Chicago, are Folder No. 340, Link-Belt Sand and Gravel Washery at Raritan Ridge Clay Co., and Book No. 343, Link-Belt Rope Tramway System.

GRINNELL AUTOMATIC SPRINKLER Bulletin No. 90 was recently received. This quarter's issue refers particularly to the installation of Grinnell sprinklers by firms in the printing industry.

BULLETIN W-308, containing 52 pages covering Duplex Piston Pattern Pumps, has just been received from Worthington Pump & Machinery Corporation, 115 Broadway, New York City.

LET 85 PER CENT MAGNESIA Defend Your Steam is the title of a pamphlet presenting a study of the cause and prevention of heat losses in the transmission of steam for power or heating purposes. This pamphlet is sent out by the Magnesia Association of America; office of the secretary, 702 Bulletin Bldg., Philadelphia.

FROM BURT MFG. CO., Akron, Ohio, we have just received a 128-page catalog giving description, illustrations and price lists of Cross American and Warden oil filters, the Burt oil filtering system, Burt and Standard exhaust heads, the Burt combination skylight and ventilator, and the Burt rotary ventilator.

THE TWENTY-SIXTH annual edition of Hendricks' Commercial Register of the United States for Buyers and Sellers has just been published, by S. E. Hendricks Co., Inc., 2 W. 13th St., New York. This standard publication is especially devoted to the interests of the architectural, engineering, contracting, electrical, hardware, iron, mechanical, mill, mining, quarrying, railroad, steel and kindred industries. Full lists are included of producers, manufacturers, dealers and consumers, listing all products, from the raw material to the finished article, together with the concerns handling these products, from the producer to the consumer. There are 2209 pages of text matter and the index to trade classifications numbers 151 pages, covering over 50,000 trade references. The list of trade names, brands, titles of identification, etc., numbering 1212 pages, furnishes ready reference to distinctive products manufactured by concerns listed in the work. The alphabetical section is included for the first time and contains in one alphabetical list the name, trade description and address of every concern appearing in the book.

BULLETIN W-500, Pot Valve Pressure Pumps, has just been received from Worthington Pump and Machinery Corporation, 115 Broadway, New York.

LINK-BELT Electric Hoists, Book No. 246, was recently issued by Link-Belt Co., New York.

Casings for Link-Belt silent chain drives are described and illustrated in Book No. 342 of that company.

THE LATEST NUMBER of the Esterline Graphic, published by The Esterline Co., Indianapolis, Ind., entitled Electrical Surveys of Industrial Plants, explains the meaning of an electrical survey and tells how it is made.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC.

required by the Act of Congress of August 24, 1912, of Power Plant Engineering, published Semi-Monthly at Chicago, Ill., for October 1, 1917.

State of Illinois } ss.
County of Cook }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Chas. Sanford Clarke, who, having been duly sworn according to law, deposes and says that he is the Secretary of Power Plant Engineering, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse side of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Name of— Post-Office Address—
Publisher, Technical Publishing Co., 537 S. Dearborn St.
Editor, Arthur L. Rice, 537 S. Dearborn St.
Managing Editor, Arthur L. Rice, 537 S. Dearborn St.
Business Manager, E. R. Shaw, 537 S. Dearborn St.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

E. R. Shaw, 537 S. Dearborn St.
Arthur L. Rice, 537 S. Dearborn St.
Chas. S. Clarke, 537 S. Dearborn St.
C. B. Leech, 1472 W. Clifton Blvd., Cleveland, Ohio.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

There are none.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other persons, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is.....

(This information is required from daily publications only.)

Chas. Sanford Clarke, Sec'y.

Sworn to and subscribed before me this 22nd day of September, 1917. Warren A. Lathrop, Notary Public.

(SEAL) (My commission expires October, 1918.)

NOTE.—This statement must be made in duplicate and both copies delivered by the publisher to the postmaster, who shall send one copy to the Third Assistant Postmaster General (Division of Classification), Washington, D. C., and retain the other in the files of the post office. The publisher must publish a copy of this statement in the second issue printed next after its filing.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

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Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—By engineer with 11 years' experience in 325 hp. plant. Married. Steady and sober. Would like to get day work in Illinois. Address Box 497, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 11-1-17

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POSITION WANTED—As engineer or oiler in power or ice plant. Have had 15 years' experience. Fred J. Waite, 659 Douglas Ave., Aurora, Ill. 10-15-1

POSITION WANTED—By a licensed operating engineer with 5 years' experience. At present employed, but would like to make a change and locate in or near Philadelphia. Will consider position as operating or chief engineer at $150 per month. Can furnish best of references from present employer. Address Horace D. Ferrell, Box 501, Marcus Hook, Pa. 10-15-1

POSITION WANTED—Chief engineer desires change of location. Competent to handle large plant. Experienced with a.c. and d.c. machinery, irrigating machinery, ammonia compressors (practical ice-maker), gas engines and air compressors. Can install and do repairs. Not liable to conscription. Address Box 495, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 10-15-1

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WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—For immediate service two (2) experienced salesmen, thoroughly familiar with high-grade centrifugal and direct-acting pumps; one for New England and one for Philadelphia. Address Box 496, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

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WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

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FOR SALE—250-volt, direct-connected units. 100-kw. G.E. with Ridgway engine, $2200; 75-kw. G.E., 3-wire, with Buckeye engine, $2000; 50-kw. Allis with Harrisburg, $1200; 30-kw. G.E. with Harrisburg, $900. Power Machinery Exchange, Jersey City, N. J.

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Sparks From The Advertising Pages

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Repetition is unquestionably the greatest power on earth. Few are the inventions that can be traced to a spontaneous origin. The original idea may come like a flash out of darkness but modifications of this idea are always necessary. And then repeated efforts in experiments and tests are imperative in bringing the concrete object to its state of perfection.

This is not only true in the world of invention, but in every line of honest endeavor. The child in its infancy learns to walk only after it has fallen repeatedly, but practice makes perfect—and so repetition teaches the very first lessons of life. The history of all great achievements can be summed up in the word—Repetition.

One but needs to look into the annals of history and of literary and scientific achievement to find written therein the Successes that would have been unrecorded failures had it not been for the dogged determination of those closely associated with the idea.

Strangely enough, the study of an idea has often uncovered new possibilities until the prospects which were once considered narrow have widened to tremendous proportions. We think of wireless telegraphy in the realm of despatch, but how many among us thought of its marvelous powers in guiding manless water craft?

In more than one instance, advertisers in POWER PLANT ENGINEERING, through the response to their publicity, have discovered new markets for their products—totally new fields which they never thought were open to them.

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The moral of this little essay is simply this:—Whatever your line of endeavor, if it is legitimate and interesting—just keep on keeping on.